electronics

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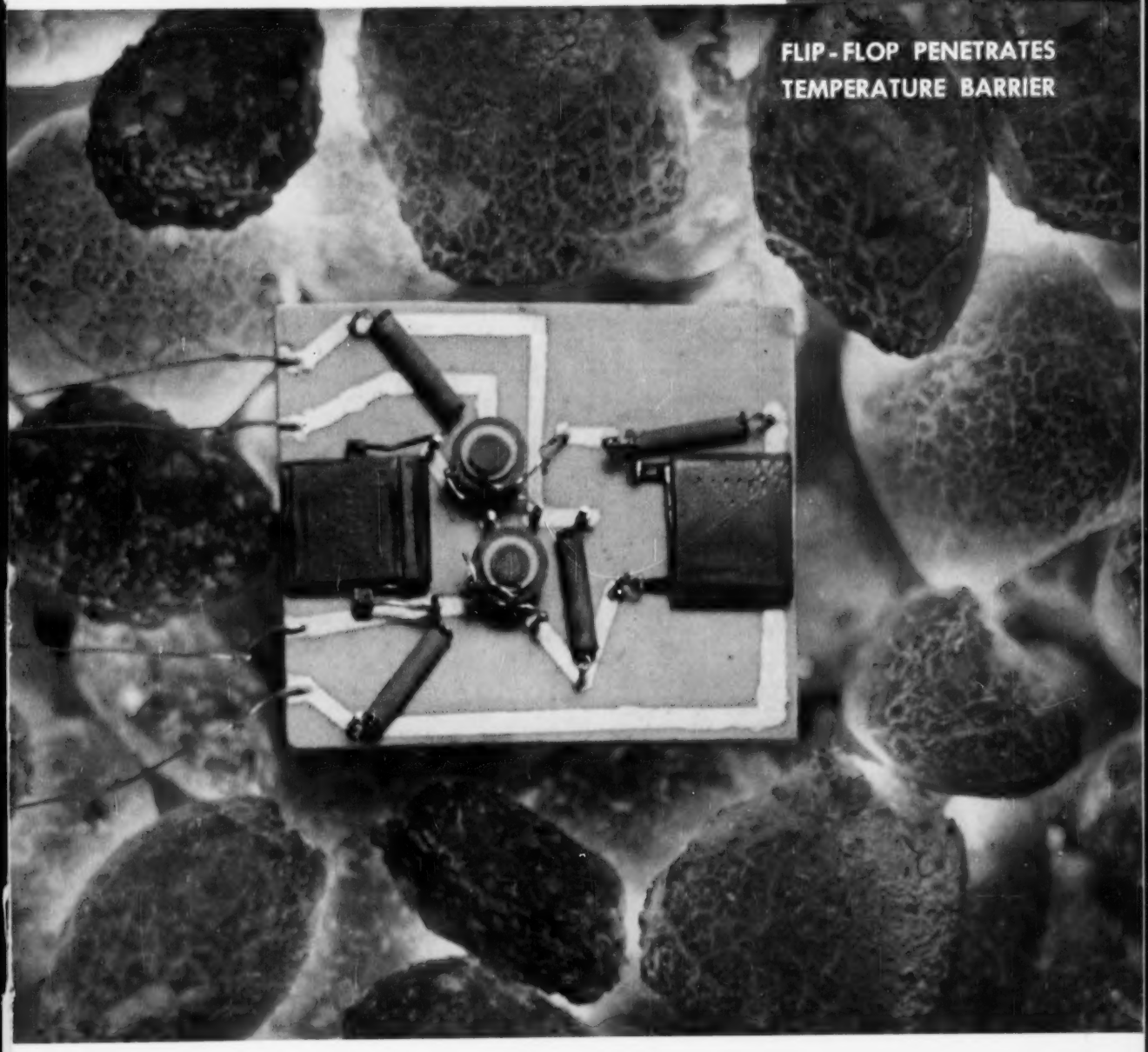
MAY 1, 1957



FLIP-FLOP PENETRATES TEMPERATURE BARRIER

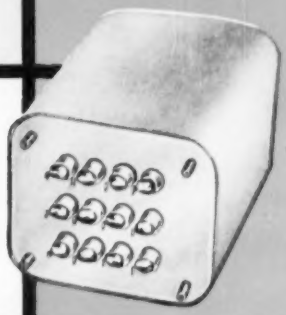
COLOR TEST SIGNAL ..... page 146

Analyzing Ignition ..... page 150

Design Against Radiation .. page 155

NEW HERMETIC POWER COMPONENTS

HIGHEST RELIABILITY FOR MILITARY AND INDUSTRIAL USE



Listed below are just a few of the 50 new **stock items** in the United hermetic power series. These MIL-T-27A power components add to the 200 other hermetic stock items of filter, audio, and magnetic amplifier types. Through the use of proven new materials and design concepts, an unparalleled degree of life and reliability has been attained, considerably exceeding MIL-T-27A requirements. Test proved ratings are provided, not only for military applications but for **industrial, broadcast, and test equipment service (55° C. ambient).**

For complete listing of these new items, write for Catalogue #56.

MIL-T-27A RATINGS IN REGULAR TYPE — INDUSTRIAL RATINGS IN BOLD TYPE

TYPICAL POWER TRANSFORMERS, PRI: 115V., 50-60 cycles.

Type No.	HV Sec. C.T.	Approx* DC volts	DC MA	Fil. Wdg.	Approx* DC volts	MA DC	Fil. Wdg.	MIL Case
H-81	500	L 180	65		L 170	75		
		C 265	55	6.3VCT-3A	C 240	65	6.3VCT-3A	HA
	550	L 200	60	5V-2A	L 190	70	5V-2A	
		C 300	50		C 280	60		
H-84	700	L 255	170		L 240	210		
		C 400	110	6.3V-5A	C 360	150	6.3V-6A	KA
	750	L 275	160	6.3V-1A	L 260	200	6.3V-1.5A	
		C 420	105	5V-3A	C 380	140	5V-4A	
H-87	730	L 245	320		L 210	420		
		C 390	210	6.3V-6A	C 350	310	6.3V-6A	NB
	800	L 275	300	6.3V-2A	L 245	400	6.3V-2A	
		C 440	200	5V-4A	C 400	300	5V-4A	
H-93	1000	L 370	280	6.3V-8A	L 340	340	6.3V-10A	OA
	1200	L 465	250	6.3V-4A	L 455	300	6.3V-5A	
				5V-6A			5V-6A	

*After appropriate H series choke. L ratings are choke input filter, C ratings are condenser input.

United "H" series power transformers are available in types suited to every electronic application. Proven ratings are listed for both high voltage outputs . . . condenser and choke input filter circuits . . . military and **industrial** applications.

United "H" series filter reactors are extremely flexible in design and rating. Listings show actual inductance at four different values of DC. Bold type listings are **industrial** application maximums.

A FEW TYPICAL LISTINGS OF FILTER REACTORS.

Type No.	Ind. Hys.	MA DC	Ind. Hys.	MA DC	Ind. Hys.	MA DC	Ind. Hys.	MA DC	Res. Ohms	Max. DCV* Ch. Input	Test V. RMS	MIL Case
H-71	20	40	18.5	50	15.5	60	10	70	350	500	2500	FB
H-73	11	100	9.5	125	7.5	150	5.5	175	150	700	2500	HB
H-75	11	200	10	230	8.5	250	8.5	300	90	700	2500	KB
H-77	10	300	9	350	8	390	6.8	435	60	2000	5500	MB
H-79	7	800	6.5	900	6	1000	5.5	1250	20	3000	9000	9x7x8

*Based on maximum ripple voltage across choke in choke input filter circuit, in terms of DC output voltage.

TYPICAL FILAMENT TRANSFORMERS, PRI: 105/115/210/220V., 50-60 cycles.

Type No.	Sec. Volts	Amps. (MIL)	Amps. (Ind)	Test Volts RMS	MIL Case
H-121	2.5	10	12	10000	JB
H-124	5	3	3	2000	FB
H-127	5	20	30	21000	NA
H-131	6.3CT	2	2.5	2500	FB
H-132	6.3CT	6	7	2500	JA
	6.3CT	6	7		
H-136	14, 12, 11CT	10	14	2500	LA

United "H" series filament transformers have multi-tapped primaries, good regulation, and are rated for **industrial** as well as military service.

United "H" series plate transformers incorporate dual high voltage ratings and tapped primaries to provide versatile units for a wide range of military and **industrial** electronic applications. Large units have terminals opposite mounting for typical transmitter use.

TYPICAL PLATE TRANSFORMERS, PRI: 105/115/210/220V., 50-60 cycles.

No. Type	Sec. V. C.T.	Approx.* DC volts	MA DC	Choke No.	MA DC	Choke No.	Case
H-110	1050	380	275	H-75	385	H-77	MB
	1200	465	250	H-75	350	H-77	
H-113	2500	1050	280	H-77	340	H-77	5¼ x 6 x 7
	3000	1275	250	H-76	300	H-76	
H-115	3500	1500	265	H-77	350	H-77	8¾ x 6½ x 8
	4400	1900	225	H-77	300	H-77	
H-117	5000	2125	900	H-79	1100	H-79	13½ x 11 x 14½
	6000	2550	800	H-79	1000	H-79	

*After filter choke. All ratings are for choke input filter.

UNITED TRANSFORMER CO.

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FLIP-FLOP PENETRATES TEMPERATURE BARRIER—Successful operation of printed-wiring multivibrator circuit on red-hot charcoal demonstrates ability of GE-developed components to operate above critical temperature barrier of supersonic aircraft and missiles (see p 158)..COVER

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SHOP

▶ **THREE EDITIONS** . . . One of the things editors learn is that when they have something really important to tell subscribers it should be told again, again and again; not every subscriber reads every word in every issue of any magazine. So, we say again:

All ELECTRONICS' *subscribers have been receiving two Business Editions and the Technical Edition each month since the first of this year. The Technical Edition is dated the first of each month, the Business Editions the 10th and 20th.*

And, in June, all subscribers will also receive our usual Buyers' Guide Issue too.

▶ **BANDWIDTH** . . . Editorial coverage in the feature article section in 1956 breaks down as follows, subject-wise and number of pages:

Antennas	10
Audio	11
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Circuits	62
Communications	62
Components	85
Computers	79
Industrial	77
Measurements	50
Microwave	21
Power Supplies	17
Radar	50
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The classifications are arbitrary, were picked because they were easy to define. Some transmitters are included under communications, and power supplies were naturally only unusual types. Telemetering includes telecontrol.

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MAY 1, 1957 Vol. 30, No. 5

Member ABC and ABP

TALK

ELECTRONICS' staff is impressive quantitatively as well as qualitatively. Ninety percent of the men listed on our masthead attended this recent planning session

▶ **RELIABILITY** . . . One of the editors recently made a field trip into the land of baked beans and brown bread. He gathered much data on current engineering problems and their solutions and was exposed to lots of highly accurate and precise equipment that also involved high reliability and resistance to extremes of temperature and moisture.

Preparing to return to New York by air, associate editor Kinn was faced with an environment problem. It seems spring had sprung a leak over New York and vicinity, closing all the airports. Reporting to the railroad, he got home at 2:30 a.m. instead of 7:00 p.m., rather wide tolerance compared to those to which he had just been exposed.

There was no electronic equivalent to one situation, though. He was pleasantly surprised to find two lovely airline stewardesses in his car taking care of sun-burned passengers who were returning from Bermuda and were forced to bypass New York and land in Boston.

▶ **INFORMATION CIRCLE** . . . Like all magazines, we get a lot of inquiries for technical and business information. We try to help in every case, but sometimes get more puzzled ourselves.

A Mr. X phoned frantically recently and said that we had published an article a few months ago and that he wanted to locate the issue. It was written by a Mr. A of company B and mentioned a development by still another company C.

Search of authors' names on recent articles showed none by Mr. A. Only recourse was to find out if any editor had any recollection of a mention of development C.

Finally we located something on the development. It was not, however, written by Mr. A but by Mr. M and not affiliated with company B, but company N.

To further our dismay, it hadn't yet been published, so Mr. X couldn't have seen it yet.

▶ **BEST SOURCE** . . . During one of the lectures in a course at the City College of New York on principles of missile guidance, assistant editor Manoogian was pleasantly surprised.

Almost all of the references recommended by the instructor, a Bell Labs man, were circuit articles that had been published in recent issues of ELECTRONICS.

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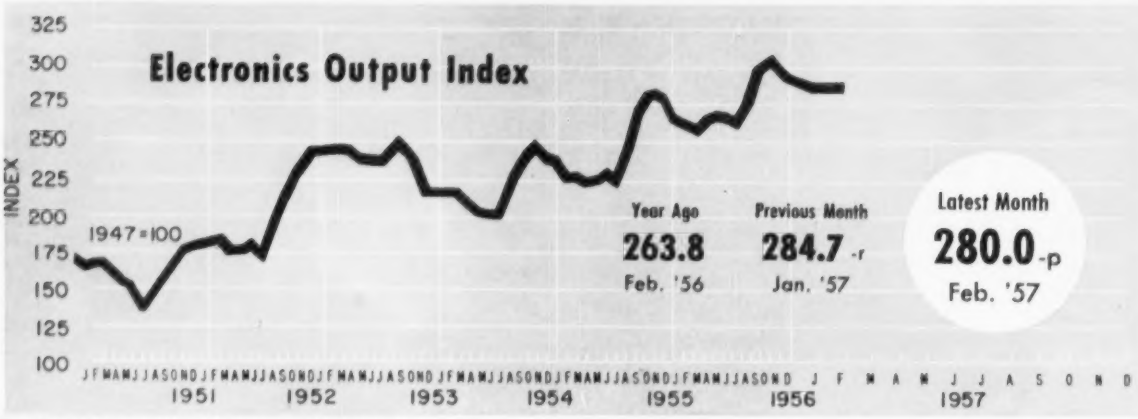


FIGURES OF THE MONTH

RECEIVER PRODUCTION

(Source: RETMA)	Latest Month	Previous Month	Year Ago
	Feb. '57	Jan. '57	Feb. '56
Television sets, total	464,697	450,190	576,282
With UHF	68,219	67,079	78,956
Color sets	nr	nr	nr
Radio sets, total	1,264,765	1,085,529	1,093,506
Auto sets	522,859	521,624	437,611

RECEIVER SALES

(Source: RETMA)	Feb. '57	Jan. '57	Feb. '56
Television sets, units	525,437	623,359	530,554
Radio sets (except auto)	525,029	563,363	454,867

RECEIVING TUBE SALES

(Source: RETMA)	Feb. '57	Jan. '57	Feb. '56
Receiv. tubes, total units	44,460,000	37,571,000	37,754,000
Receiv. tubes, value	$36,631,000	$31,170,000	$30,756,000
Picture tubes, total units	728,363	760,860	898,063
Picture tubes, value	$13,134,778	$13,594,525	$17,136,695

INDUSTRIAL TUBE SALES

(Source: NEMA)	Quarterly Figures: Latest Quarter	Previous Quarter	Year Ago
	4th '56	3rd '56	4th '55
Vacuum	$12,408,371	$8,895,012	$9,967,411
Gas or vapor	$3,223,612	$2,936,765	$3,251,621
Magnetrons and velocity modulation tubes	$15,890,681	$14,948,477	$13,726,323
Gaps and T/R boxes	$1,242,745	$1,196,369	$1,578,767

MILITARY PROCUREMENT

(Source: Defense Dept.)	4th '56	3rd '56	4th '55
Army	$56,185,000	$23,107,000	$48,477,000
Navy	$34,210,000	$22,273,000	$20,378,000
Air Force	$145,962,000	$84,952,000	$131,938,000
Total—Electronics	$236,357,000	$130,332,000	$200,793,000

BROADCAST STATIONS

(Source: FCC)	Latest Month	Previous Month	Year Ago
	Feb. '57	Jan. '57	Feb. '56
TV stations on air	515	513	485
TV stations CPs—not on air	123	120	106
TV stations—new requests	56	62	22
A-M stations on air	3,031	3,014	2,841
A-M stations CPs—not on air	133	123	123
A-M stations—new requests	303	288	247
F-M stations on air	529	527	539
F-M stations CPs—not on air	23	24	13
F-M stations—new requests	10	8	4

COMMUNICATION AUTHORIZATIONS

(Source: FCC)	Feb. '57	Jan. '57	Feb. '56
Aeronautical	50,859	54,243	44,570
Marine	61,246	60,774	54,637
Police, fire, etc.	22,500	22,450	19,971
Industrial	33,879	33,456	28,054
Land transportation	9,484	9,476	8,726
Amateur	158,232	157,275	145,427
Citizens radio	23,888	23,155	15,563
Disaster	343	331	327
Experimental	735	721	652
Common carrier	2,666	2,618	2,176

EMPLOYMENT AND PAYROLLS

(Source: Bur. Labor Statistics)	Jan. '57	Dec. '56	Jan. '56
Prod. workers, comm. equip.	400,200-p	410,500-r	389,600
Av. wkly. earnings, comm.	$79.15 -p	$79.15	$74.70
Av. wkly. earnings, radio	$75.64 -p	$75.76 -r	$70.80
Av. wkly. hours, comm.	40.1 -p	40.8	40.6
Av. wkly. hours, radio	39.6 -p	40.3 -r	40.0

SEMICONDUCTOR SALES ESTIMATES

	Feb. '57	Jan. '57	Feb. '56
Transistors, Units	1,785,300	1,436,000	618,000

STOCK PRICE AVERAGES

(Source: Standard and Poor's)	Feb. '57	Jan. '57	Feb. '56
Radio-tv & electronics	330.6	336.3	323.2
Radio broadcasters	489.6	439.9	426.8

p—provisional r—revised nr—not reported

FIGURES OF THE YEAR

	TOTALS FOR THE FIRST TWO MONTHS 1957	1956	Percent Change	1956 Total
Television set production	914,887	1,164,629	—21.4	7,357,029
Radio set production	2,350,294	2,172,130	+ 8.2	13,981,800
Television set sales	1,148,796	1,144,767	+ 0.4	6,804,756
Radio set sales (except auto)	1,088,392	986,073	+10.4	8,332,077
Receiving tube sales	82,031,000	77,895,000	+ 5.3	464,186,000
Cathode-ray tube sales	1,489,223	1,790,448	—16.8	10,987,021

More Computers Go To Colleges

Four more universities will use digital types to free brain-power for more creative assignments

DIGITAL computer MISTIC, the Michigan State integral computer, will be solving mathematical problems at Michigan State University before the year is up. The device is similar in logic and general construction principles to the computer developed at Princeton Universities Institute for Advanced Study.

Similar machines now are in operation at the Argonne National Laboratory, Oak Ridge National Laboratory, Los Alamos Scientific Laboratory, the Rand Corporation of Santa Monica, Cal., and the University of Illinois. Others are under construction at Iowa State College and the University of Sydney, Australia.

► **Logic**—To solve 40 simultaneous equations, which would take weeks to do by other means, the computer would need only 193 seconds: four seconds for the problem to be introduced, 181 seconds to solve it, and eight seconds for the answer to be produced.

Composed of thousands of miles of wire and hundreds of electronic tubes and transistors, the computer will have four essential sections: input, arithmetic and control, memory and output.

Information and problems will be introduced to the machine on perforated paper tape. Answers are on tape or a page.

NEW radiotelephone system, manufactured by Du Mont, operates automatically when . . .

Mobile Radio Dials Phone Calls

Vehicle phone calls can be relayed automatically through local telephone company facilities

AUTOMATIC dial-direct mobile two-way radiotelephone system is in operation in Richmond, Indiana and is now available nationwide through Allen B. DuMont Laboratories. Designed and developed by DuMont rep Ramsey McDonald, the system allows phone calls to-and-from vehicles to be relayed completely unattended through a local telephone system.

Calls are made from a vehicle by dialing a number within a local telephone system. Anyone within that system can call the vehicle in the same manner as in making a house-to-house call. Only when placing a toll call must the long distance operator be contacted.

► **How it works**—The system consists of a dial radiotelephone in a vehicle, employing a two-way radio system as a carrier to the local telephone company installation. A transmitter-receiver base station is interconnected with the local telephone system. Termination and switching equipment at the base station automatically transfers the radio calls to the telephone system and telephone calls to the radio system.

Calls can also be made from vehicle to vehicle. Two telephone lines are required to interconnect

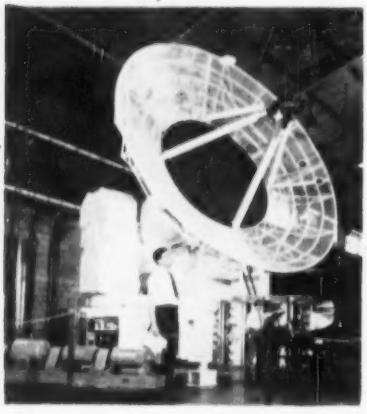
the base station equipment with the telephone company's central office. One line is utilized for calls from telephone to radio; the other for radio to telephone.

▶**Market**—Substantial sales of the systems are expected to be made to independent telephone companies. There are 4,500 such independents and 69 percent of their service is dial.

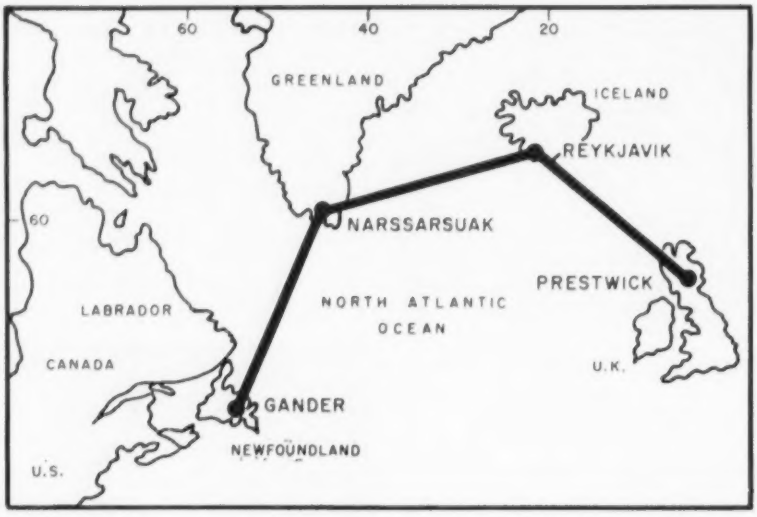
The system presently used by Richmond Radiotelephone, headed by McDonald, provides mobile radio telephone service for subscribers in Richmond and surrounding areas.

▶**Cost**—Interconnected with the Richmond Home Telephone Co., the system provides dial-direct service of 24 calls per day for $40 per month per unit with the lease of DuMont equipment. Using privately owned mobile equipment costing about $500, the service would run about $25 a month. For a company that wants to go into business to operate the service the cost of the equipment including base station (transmitter and receiver), two antennas, termination and switching equipment, would run about $7,000.

Scores Missile On The Spot



Direct calibration and immediate evaluation of the performance and behavior pattern of guided missiles is handled by this new instrumentation radar system developed by RCA. Antenna pedestal shown is designed for mounting on a separate tower to minimize vibration



PROPOSED air-ground communications network connecting Newfoundland, Greenland, Iceland and the United Kingdom—Ireland will use forward propagation-by-ionospheric-scatter stations to help eliminate transmission blackouts as . . .

Nations Plan N. Atlantic Link

Twelve IACO nations chalk out framework for scatter stations that will cure bad signals

DURING the summer of 1956, more than half of the flights across the North Atlantic suffered radiocommunication blackouts caused by sub-Arctic auroral disturbances, which affect existing high-frequency radioteletype circuits.

A decision by the Canadian government to build a $650,000 vhf forward-propagation-by-ionospheric-scatter station near Gander airport, Newfoundland will implement a new chain using high-power transmitters, 50 to 100 kw, working in the very-high frequency band, between 30 and 60 mc. Highly directional antennas will be used.

Signals are scattered by the highly-ionized layer of air 55 miles above the earth and are reflected to ground receiving stations a distance away.

The International Civil Aviation Organization (IACO) recommended the network to facilitate flight - information transmission and the Canadian government agreed to contribute to joint financing of stations in Greenland and Iceland.

▶**Links**—The IACO plan envisages the use of three links, one between Newfoundland and Greenland, a second between Greenland and Iceland and a third from Iceland to the United Kingdom and Ireland. All of these would be integrated as a single system and provide four teletypewriter channels and one telephone channel between the points served.

As an alternative to the link between Iceland and the United Kingdom-Ireland, Iceland proposed an undersea telephone-telegraph cable that would provide similar channels to be integrated with the vhf forward-scatter system between Iceland and North America.

▶**Service**—The principal concerns of the proposal have to do with the reliability and quality of service that can be expected and the methods of organization necessary to ensure full coordination in the implementation of the entire plan.

Further response to the recommendations offered by IACO will be received, not later than May 1st from twelve ICAO nations and two international organizations: the International Air Transport

(Continued on page 10)

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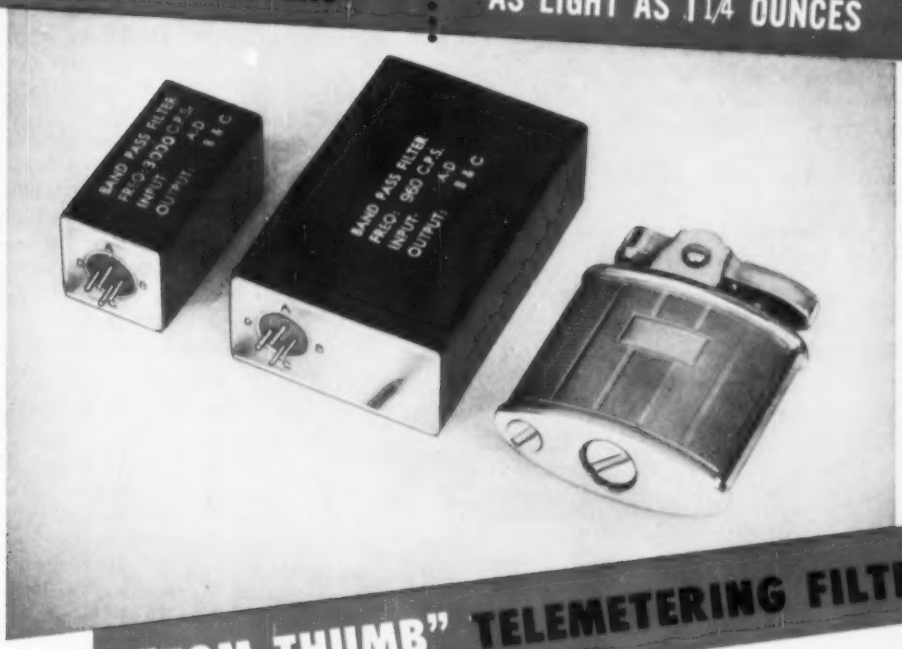

"TOM THUMB" TELEMETERING FILTERS

CHAN. #	FREQ.	IMP. 100K P/N	B. W.	SIZE	WT.
1	400 cps.	S-60001	±7½%	¾ x 1½ x 2¼ H	4 oz.
2	560 cps.	S-60002	±7½%	¾ x 1½ x 2¼ H	4 oz.
3	730 cps.	S-60003	±7½%	¾ x 1½ x 2¼ H	4 oz.
4	960 cps.	S-60004	±7½%	¾ x 1½ x 2¼ H	4 oz.
5	1300 cps.	S-60005	±7½%	¾ x 1½ x 2¼ H	4 oz.
6	1700 cps.	S-60006	±7½%	¾ x 1½ x 2¼ H	4 oz.
7	2300 cps.	S-60007	±7½%	¾ x ¾ x 1⅜ H	1¼ oz.
8	3 KC	S-60008	±7½%	¾ x ¾ x 1⅜ H	1¼ oz.
9	3.9 KC	S-60009	±7½%	¾ x ¾ x 1⅜ H	1¼ oz.
10	5.4 KC	S-60010	±7½%	¾ x ¾ x 1⅜ H	1¼ oz.
11	7.35 KC	S-60011	±7½%	¾ x ¾ x 1⅜ H	1¼ oz.
12	10.5 KC	S-60012	±7½%	¾ x ¾ x 1⅜ H	1¼ oz.
13	14.5 KC	S-60013	±7½%	¾ x ¾ x 1⅜ H	1¼ oz.
14	22 KC	S-60014	±7½%	¾ x ¾ x 1⅜ H	1¼ oz.
15	30 KC	S-60015	±7½%	¾ x ¾ x 1⅜ H	1¼ oz.
16	40 KC	S-60016	±7½%	¾ x ¾ x 1⅜ H	1¼ oz.
17	52.5 KC	S-60017	±7½%	¾ x ¾ x 1⅜ H	1¼ oz.
18	70 KC	S-60018	±7½%	¾ x ¾ x 1⅜ H	1¼ oz.
A	22 KC	S-60019	±15%	¾ x ¾ x 1⅜ H	1¼ oz.
B	30 KC	S-60020	±15%	¾ x ¾ x 1⅜ H	1¼ oz.
C	40 KC	S-60021	±15%	¾ x ¾ x 1⅜ H	1¼ oz.
D	52.5 KC	S-60022	±15%	¾ x ¾ x 1⅜ H	1¼ oz.
E	70 KC	S-60023	±15%	¾ x ¾ x 1⅜ H	1¼ oz.

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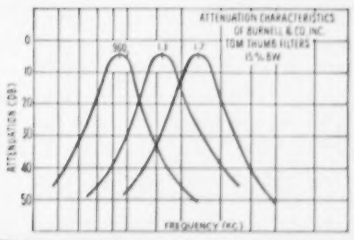
Supplied in two principal case sizes:

1. For RDB channels 1 through 6, case size is ¾ x 1½ x 2¼ inches high; weight: 4 ounces.
2. For channels 7 and up, case size is ¾ inches square and 1⅜ inches high; weight: 1¼ ounces.

These cases are generally equipped with a 4-pin plug to match the small Winchester socket.

ATTENUATION CHARACTERISTICS

Impedance: 100 K ohms in and out.
Insertion loss: less than 6 db.
At ± 7.5% band width is less than 3 db.
At ± 25% band width is greater than 15 db.
At 1.75 f attenuation is 40 db or more.
At .57 f attenuation is 40 db or more.



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Association (IATA) and the International Frequency Registration Board (IFRB).

▶ **Tropo Scatter**—In Alaska, an additional link between Kenai and Homer, Alaska was added to the White Alice system that combines service for the military and commercial communications (ELECTRONICS, p 192, Jan., 1957). This broad-band tropospheric radio equipment was designed and manufactured by Radio Engineering Laboratories for Western Electric.

Another wide-band link that will accommodate a tv channel and 120 telephone conversations is scheduled for cutover by AT&T in late summer. Equipment will be shipped soon from Federal Telecommunication Laboratories for the Florida-Cuba circuit.

Equipment recently completed by Philco for the Air Force also uses the tropospheric transhorizon phenomenon at about 8 kmc.

COMPLEX radar control, the brain of F-94 interceptor planes guarding the North American continent, is checked and installed by Hughes technician while . . .

Air Force Expands Modernization

Intricate modern weapons require more dollars to rework existing electronic systems

MODERNIZATION costs for aircraft systems have risen 67 percent in the past three years. The figure is expected to reach $1.4 billion for the fiscal year 1957, compared to $992 million for fiscal year 1954.

Of this total, a substantial portion, possibly $200 million annually, goes to modernize electronic equipment. The total includes all major maintenance performed at Air Force depots or contractor's plants, as well as modification of in-service aircraft and component equipment. As demand for higher combat effectiveness continues, the work and expense required for modernization will continue to increase proportionately.

▶ **Units**—During fiscal 1957, the Air Force has scheduled about 8,500 aircraft for major maintenance and modification, of which about 6,500 jobs are to be accomplished by contractors. The increased number of complex, high performance jet aircraft require many more man-hours of maintenance and modification than their World War II predecessors.

Active military aircraft inventory has increased in number and by far more complex weapon systems. For example, in the F-94 interceptor plane shown, the control equipment manufactured by Hughes Aircraft Co. has as many different parts as 200 television sets.

Labor costs for total maintenance and modification have risen from around $20,000 for a World War II bomber to over $500,000 for a modern jet bomber. The Defense Department estimates that there are over 150,000 civilian and military personnel in electronic maintenance work.

▶ **Bombers** — Lockheed has been working on a Box-Kite modification program since last year. Additional Air-Force business came to its Georgia Division plant at Marietta for early delivery of 21 quality-modified B-47 Stratojets. Latest engineering and electronics improvements will be added at the same time the aircraft are undergoing major overhaul. Thus, within two weeks a total of 113 aircraft were added to current B-47 modernization projects at the plant.

▶ **Future**—To maintain an inventory of weapon systems in the condition necessary to keep ahead of potential enemy airpower, the Air Force must continue to modernize existing aircraft, according to Aircraft Industries Association, or to incorporate new weapon systems in its inventory. The cost trend of modernization tends to follow the cost of the new weapon systems.

TV's Second Set Market Still Looms Large

Homes with two sets represent only 4 percent of total but portables are making inroads

TELEVISION set producers have pushed sales possibilities of two tv sets to each home but not until last year did such sales finally take hold. According to Commerce Department figures, the number of homes with two sets went from 2

(Continued on page 12)

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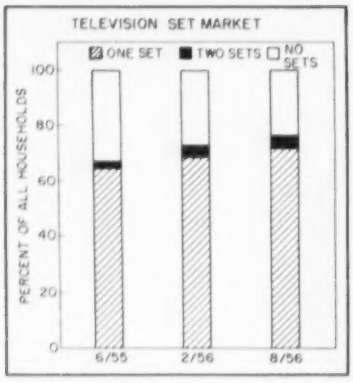


percent to 4 percent of total households between June '55 and August '56.

► **Reason**—Compactness and lower price seem to be the keys to the second set market. History seems to be repeating. Not until the compact table model radio, styled for each room and priced right, was introduced did the multiple radio set market really reach its full potential.

The rise in portable tv sales began in the second half of 1955 and coincides with the rise in second set households. TV cabinets are now multicolored to fit any decor and compactness along with low price are featured.

► **Effect of size?**—The 110-degree tube permits sets to be six inches shorter. Sylvania reports that its February tv set sales achieved a new record of more than double February 1956 sales.

Business Briefs

► **Acquisition** of Radio Receptor by General Instrument involved purchase by GI of 80 percent of the outstanding stock of Radio Receptor. Of RR current production, 80 to 85 percent is for industrial and military purposes, 15 to 20 percent for radio and tv

► **Sales** in Australia, Italy and Mexico for Admiral Corp. totaled $9 million in 1956. Sales target for the three counties in 1957 is $20 million and the company will undertake additional foreign manufacturing operations in the next two years

► **Expenditures** for expansion of facilities in 1956 by GE amounted to $205.2 million, more than $34 million higher than any previous year in the firm's history. Total of $1.4 billion has been invested by the company in its expansion and modernization program since World War II

► **Six** U.S. airlines, 13 foreign commercial airlines and the Royal Australian Air Force purchased RCA weather radar during 1956

► **Ten** percent of total sales of High Voltage Engineering was devoted to research and development in 1956. The firm's backlog reached $6 million with approximately half that amount representing orders from abroad

► **Net** sales of Minnesota Mining have climbed by about 100 million in the past two years, reached $330.8 million last year. Electrical products accounted for 17 percent of 1956 sales

Scientists Look Into Future Of Switching

Discussions at Harvard show trends in such fields as chemical and cryogenic switches

CORE of the remarkable progress achieved in the field of computers and mechanization is the science of switching which deals with the on-off, high-low and conducting-non-conducting states of mechanical and electronic devices.

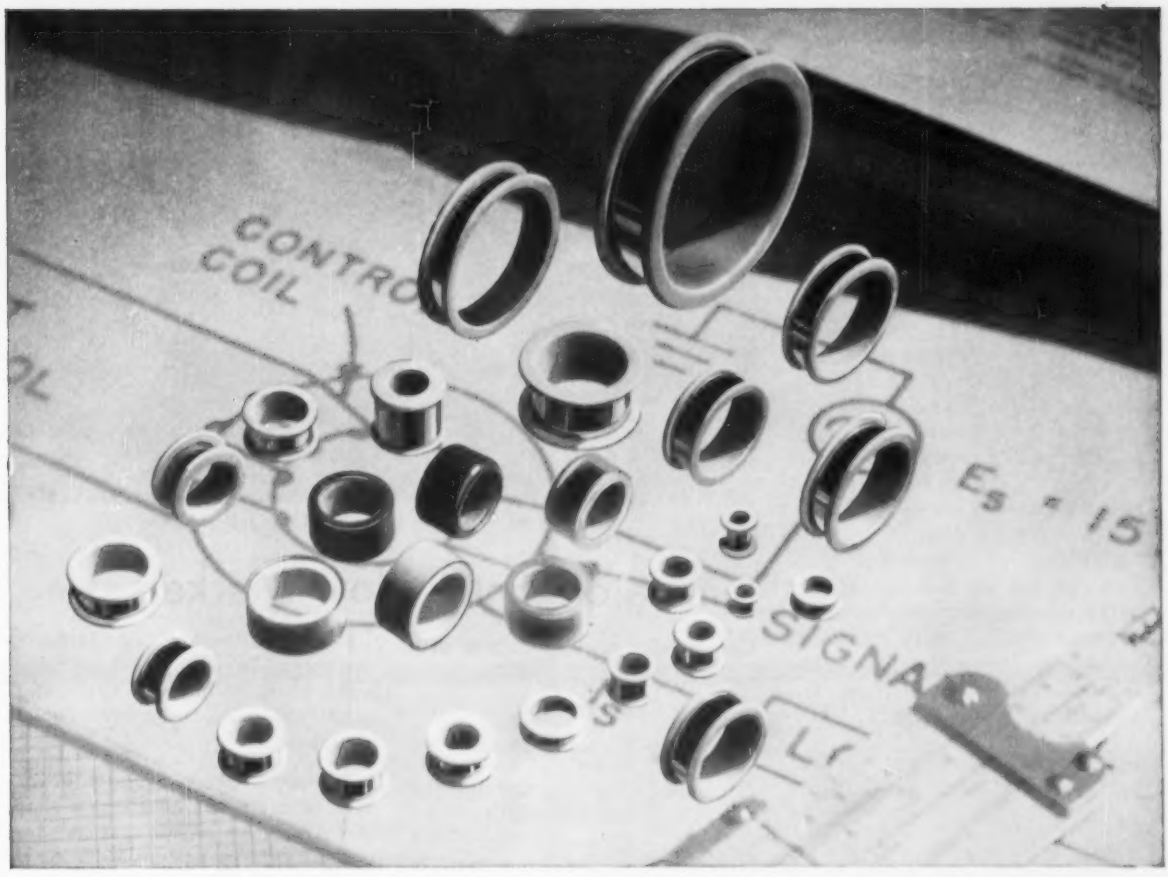
Recently, approximately 1,000 scientists gathered at Harvard to discuss the progress of work in this field and much light was shed on present thinking and planning.

► **Chemical**—It was shown that chemical reactions, such as take place when light-sensitive or photochromic materials are exposed to the proper wavelength of light causing the material to change color, can provide the two stable states required for switching. It was explained by B. K. Green of National Cash Register Co. that tiny droplets of these materials when enclosed in a structure, consisting of cells two and a half microns in diameter, would produce a device with 100-million switches per square inch.

► **Superconductor**—A woven memory device made of strands of superconducting wire woven through coils and immersed in liquid helium was discussed by A. E. Slade of Arthur D. Little, Inc. Each strand of wire has a unique path through the coils thereby making it one word in the memory. By properly combining 10,000 wires and 20 coils, a 10,000 20-bit word catalog memory of pencil size becomes feasible.

► **Magnetics**—A method of increas-

(Continued on page 14)



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ing computing times to the millimicrosecond region through the reversal of magnetic spins occuring in thin ferromagnetic films led H. Callen of the University of Pennsylvania to conclude that these films would make satisfactory switches and increase computing time a thousand-fold.

► **Microwaves** — Another possible way of increasing computer speeds was discussed by W. D. Lewis of Bell Telephone Laboratories who described a possible combination of microwave components, some of which are still in the laboratory stage, to perform logical functions. High speed is attained because bandwidths of 700 mc and pulse rates of 160 mc can be obtained using microwaves.

Three methods were mentioned as ways to increase speed: detection followed by modulation; frequency conversion and sequential logic; and maintaining the basic pulse rate higher than the reciprocal of the delays in the closed loops.

► **Theory only**—In all the above it should be emphasized that the devices mentioned are in the thinking-and-laboratory stage rather than concrete pieces of hardware.

Assembly-Line Machine-Gun

Ammunition belt feeds 3,000 semiconductors into machine that staples them into electronic circuits at Hughes Aircraft. A special machine was developed to fabricate the belts

FLIGHT simulators are used by United States Air Lines. In addition . . .

Simulators Enter New Markets

Commercial and military aircraft account for largest volume. New markets boost sales

MUSHROOMING costs of increasingly complex commercial and military equipment have boosted the importance of the growing flight simulator business and the dozen companies in the field.

There are now an estimated 1,000 flight simulators in use in the U.S. The figure does not include the increasing number of units that simulate missiles, radar, navigation and naval equipment. Sales to airlines abroad are also growing. The units range in price up to $1 million.

► **Commercial** — The airlines are important customers for flight simulators. One airline has 15 units in use. American Airlines recently ordered electronic flight simulators from Curtiss-Wright for its forthcoming fleet of Lockheed Electra propjets and Boeing 707 turbojets.

United Airlines at its flight training center in Denver, Colorado consolidated the radio communications and navigation facilities for five simulators into a radio control center. Only three sets of communications and navigation units are required in contrast with the five which otherwise would be needed. The control center was designed and built by United's flight simulator engineering group. The equipment includes more than 80 miles of wire and some 100 specially developed switches.

► **Military** — Today nearly every type of multi-engine aircraft that the Air Force has in use has its counterpart in a simulator. Now even some single engine jet fighters have simulators. In many cases, the simulators are built for crew training even before the actual planes to be flown are off the drawing boards.

Strength of the military part of the business is indicated by the fact that Erco division of ACF Industries recently had to terminate commercial orders for jet simulators because of military simulator contract priorities.

► **Companies**—Two years ago there were only about eight manufacturers in the flight simulator field, plus a few aircraft companies that built units for their own use. Today, according to Aircraft Industries Association, there are a dozen firms in the field commercially.

► **Future**—Simulators for guided missiles are gaining in importance as missiles take over more of the assignments of manned aircraft. Bendix computer division now makes a simulator for testing flght controls and guidance systems for missiles and aircraft. Tne new sys-

(Continued on page 16)

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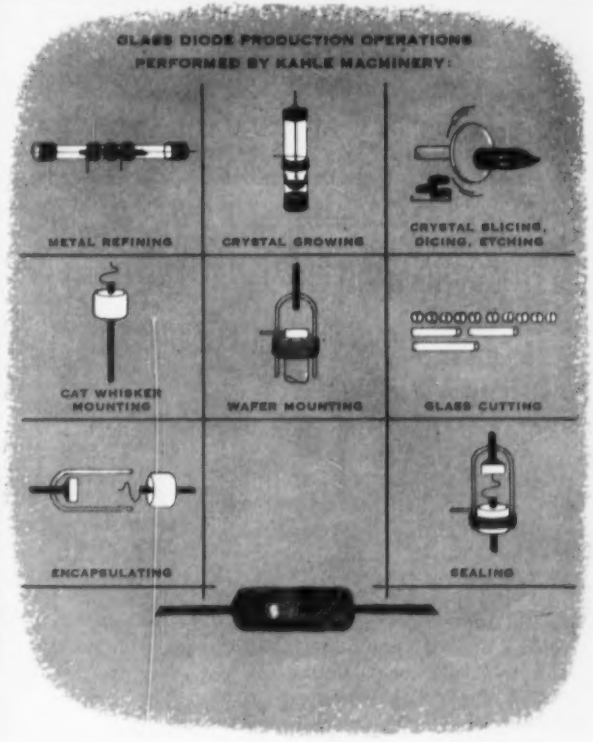

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tem reduces or eliminates the need for expensive trial flights in the evaluation and debugging of airborne systems.

Simulators are gaining in use in the Navy. A ship's characteristics demonstrator developed by Teletronics Laboratory for the U.S. Naval Training Device Center is to be used at naval training schools and reserve training centers for demonstration and exercise in the art of ship handling. The device consists of a control unit, two self-powered radio-controlled ship models and the tank.

TRANSPORTABLE midget recomp computer recently developed is one way . . .

Military Spurs Computer Work

Many specifically military units also applicable to business problems

OVERLAP areas wherein computers can be used for both military and business purposes are becoming more apparent as information becomes available on the newer units developed for the military.

► **Mini-computer**—The first model of a general-purpose, all-transistor digital computer called RECOMP has been delivered to ARDC by the Autonetics division of North American Aviation. It was designed to perform in the field and to provide as nearly equal capabilities as units costing $250,000 installed. It is a serial, single-address, internally binary computer using a rotary disk memory with a capacity of 2048 40-bit words.

Information can be fed in by decimal entry of mixed numbers, electric typewriter, paper tape reader or control panel keyboard while output may be decimal, octal or binary.

► **Applications** — Specific uses for the RECOMP show that business needs are identical to military needs as in surveying, where it can reduce data on elevations and plane tables; in construction work, to determine material strengths, grades, water flow and earth-rock movements; in navigation, to make calculations from data derived from loran-radar sources.

► **Analog**—A special-purpose, transistor-magnetic analog computer originally developed for industrial data processing systems will now find use in testing of guided missiles. The first of a series of ten such units costing a total of $109,000 and produced by Beckman Instruments will be used in ballistic missile test stands developed for Martin by Baldwin-Lima-Hamilton.

► **Statistics** — Adaptation of the "lag correction method" used in business statistics was recently introduced at the Missile Test Project at Patrick Air Force Base to aid in the solution of the problem of tracking guided missiles. It enables both photographic and radio information to be programmed for the computers resulting in increased accuracy in the answers.

Electrons Sterilize Army Foods

Army will spend $7.5 million on pilot plant to preserve foods by electron bombardment

USE of particle accelerators for food preservation takes another step forward with announcement the army will build a $7.5 million food irradiation pilot plant at Stockton, Calif. Research and Development Command of the Army Quartermaster Corps will direct the project.

► **Operation**—Four Varian Associates klystron tubes will power the accelerator. Output will be 24 million electron volts (24-mev) at peak current of 420 milliamperes. The klystrons are a version of the VA-87's made for radar.

► **Use**—Packaged food will be sterilized by irradiation, allowing unrefrigerated storage. Lower power will inhibit sprouting, deinfest or pasteurize. Varian believes army success would lead to approval of commercial food sterilization by the Food and Drug Administration.

► **Customers**—Varian now has $1 million in accelerator contracts. It is also building a one-klystron machine for a chemicals company and a two-klystron model for physics and weapons research.

► **Research**—Stanford Research In-

(Continued on page 18)

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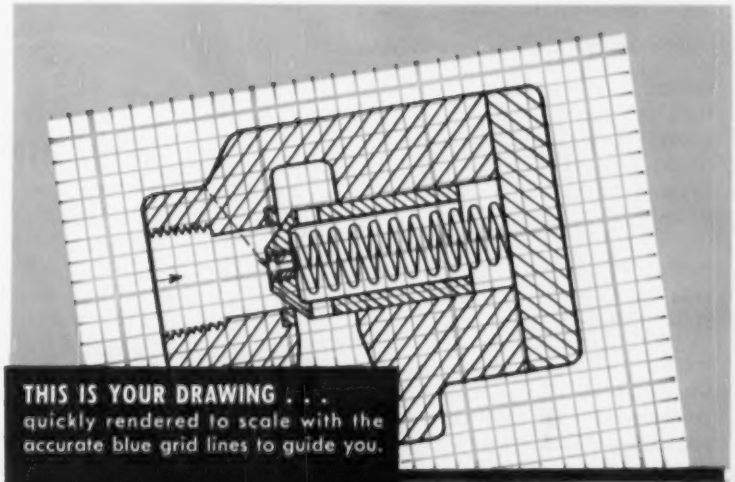

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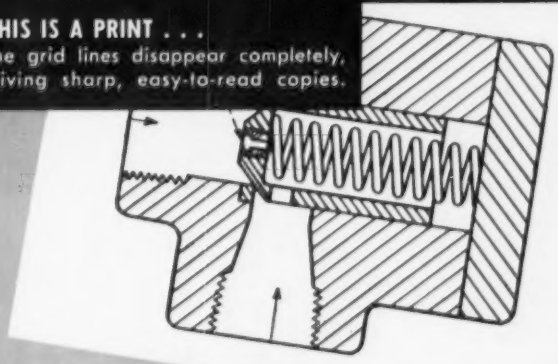

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stitute is adding a 1-mev GE resonant transformer electron-beam generator. SRI has a 2-mev Van de Graaf accelerator and a cobalt-60 source. It expects to spend over $1 million this year studying irradiation effects on plastics, polymerization, initiation of chemical reactions, effects on materials, instruments and foods.

► **Competition** — Electronized Chemicals Corp. is building the commercial prototype of its Capacitron (March, 1948, ELECTRONICS for experimentation details). The new machine is designed for high-power assembly-line food and drug sterilization and de-infestation, plastics and petrochemical work. Average output of the Capacitron will be 30 kw. It utilizes several hundred capacitors which are charged in parallel and discharged in series 60 times a second.

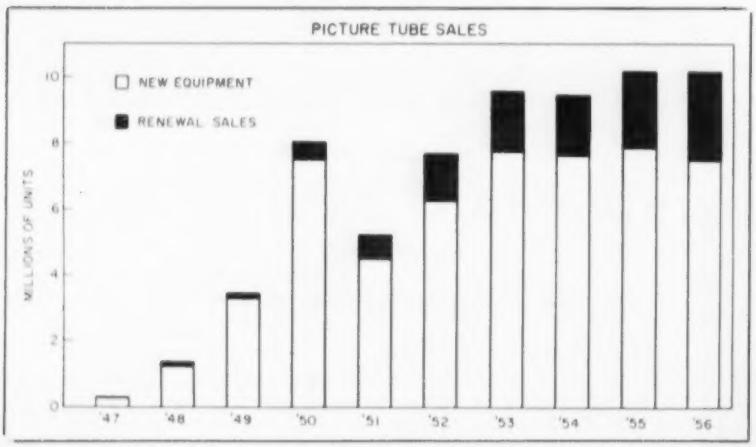
Picture Tube Renewal Sales Increase

Tube makers find replacement sales of tv picture tubes cushion tv set sales declines

ALTHOUGH the replacement business for tv picture tubes has its problems, it represents one of the more stable parts of the volatile tv manufacturing business. Although tube makers have to continually adjust for volume changes in the initial equipment market, they can, to a large degree, count on renewal sales volume at predicted rates. One of the biggest variables in the replacement picture tube business is competition, as it is in most other businesses.

► **Growth**-Size of the renewal picture tube business today and its growth since 1947 is indicated in the chart. Approximately 25 percent of the total tube business is represented by renewal sales and the percentage grows larger each year. That will continue to be the case until the picture tube itself replaced by a new development. Until that time however, tube re-

(Continued on page 20)



Military Electronics

► **Missile guidance** system contract worth $6 million for submarine launching of the Navy's Regulus missile has been awarded to Stavid Engineering. One of the new atomic submarines now on order has been designed to house, launch and guide Regulus

► **Voodoo** supersonic fighters, Air Force's new F-101B interceptors, will be equipped with Minneapolis-Honeywell MB-5 electronic automatic flight control systems under a $15.5-million contract let to the firm by the Air Material Command

► **Backlog** of defense production contracts for two divisions of American Bosch Arma is estimated at $300 million. The firm is in production on the defensive system for the B-52 intercontinental jet bomber and in development and production on the guidance system for one of the intercontinental missiles

► **Work** on airborne electronic armanent control systems will be done by Hughes Aircraft under two Air Force contracts totaling $15.4 million

► **Radio-frequency** spectroscope has been developed at Republic Aviation to detect interference in the electronics systems of newly-built jet fighter-bombers. It reduces to half a day the three or more days it has taken to check aircraft electronic equipment on the production line, according to officials of the company

► **Contract** worth $83 million for work on the guidance system for the Atlas intercontinental ballistic missile has been awarded to GE

recent ORIGINAL RAYTHEON DEVELOPMENTS made to order!

here are a few of the tubes customers asked us to create . . .

★ Raytheon excels in tailoring special tube designs to meet the most critical applications of missile, aircraft, communication, computer and industrial usage

★ Thirty-four years of special tube development and manufacture

★ Completely separate development and engineering facilities

★ Engineering control extending from development through production

★ Complete environment control of all critical manufacturing operations

★ Over 250 Raytheon developed tube types now in use

CK6832
Reliable low noise, low drift twin triode for DC amplifiers

CK6932
Filamentary pentode (CK6088) with separate suppressor

CK6872
Semi-remote cutoff CK5702WA

CK1050
Light indicator for transistorized computers

CK1051
Hard glass rectifier, PIV = 2800, I_o = 8mA

6AH6WA
Reliable video pentode

Consult Raytheon for your special tube requirements

RAYTHEON®

SPECIAL TUBE DIVISION

RELIABLE MINIATURE AND SUBMINIATURE TUBES • VOLTAGE REFERENCE TUBES
VOLTAGE REGULATOR TUBES • PENCIL TUBES • NUCLEONIC TUBES

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LOS ANGELES: 5236 Santa Monica Blvd. • NOrmandy 5-4221

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newal business will keep growing at the rate of nearly a half million units a year.

▶ **Size**—The 21-inch picture tube is estimated to account for over 50 percent of total tv tube renewal business. In 1952 the portion was only 8 percent. Despite the high percentage of 21-inch tubes, however, tube makers continue to make picture tubes for nearly every size tube that was ever produced with the possible exceptions of the 3-inch and 7-inch sizes.

One major tube maker produces within one year some 140 different kinds of crt's for replacement sales. Enough of these types are usually run off at one time in the year to take care of total annual requirements.

ACCOUNTANTS of Santa Fe Railroad cluster around computers while . . . . .

More Railroads Choose Electronics

Santa Fe and Southern Pacific install computers as aids for boxcar and statistical control

RAILROADS are switching more and more to electronics to help speed up routine. Two recent entries are Southern Pacific and Santa Fe.

▶ **Freight cars**—Southern Pacific uses data processors and a computer to mastermind its boxcar distribution. Some 70,000 car records will be sifted daily to promote car handling efficiency. The system, result of three years study, will be in full operation in July. SP expects it will help whip car supply problems.

▶ **Reservations**—Santa Fe is planning electronic installations to expedite passenger reservations. Tie-ins with eastern railroads will handle coast-to-coast ticket sales. Last year, Santa Fe bought an IBM 650 computer to handle its payroll and business data.

Other railroads are spending millions for electronic gear to centralize traffic controls, keep goods moving swiftly through freight yards.

▶ **Standbys**—Railroads have made gigantic investments in line communication equipment, according to a survey made last year by the Association of American Railroads communications section.

Reports from 104 railroads with a total mileage of 259,485 miles, show that 237,968 pole line miles were in operation. Wires strung included 455,135 miles of telephone carrier circuits and 1,160,000 miles of carrier telegraph circuits. Carrier equipment includes 4,538 voice carrier terminals, 1,043 voice carrier repeaters, 7,623 carrier telegraph terminals and 185 carrier telegraph repeaters.

Other equipment used in bulk includes paging units, 11,568; talkback units, 7,927; intercommunication systems, 1,104, with 3,273 master units and 3,209 substations. The railroads have 13,800 employes assigned to communication work.

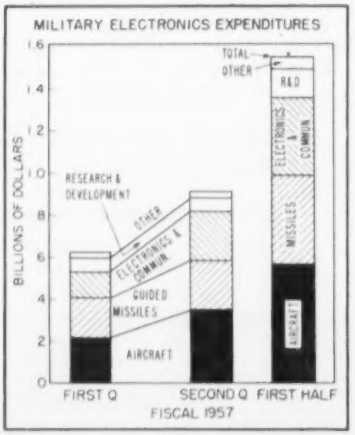
▶ **Meeting**—Association of American Railroads, communications section, holds its annual session May 21-23 in Toronto, Canada. Railroaders will hear talks and reports on new electronic development, microwave planning, high-speed communications, recorders and government actions.

Military Electronics Spending Rises

Expenditures for aircraft and communications rise sharply as missiles decline

DEFENSE military electronics expenditures increased nearly 50 percent in the second quarter of fiscal 1957 over the first quarter.

RETMA reports total expenditures rose from $632.6 million in the first quarter to $903.7 million



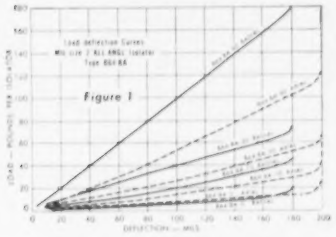
(Continued on page 22)

How to Meet Tougher Specifications for Shock and Vibration Protection in Jets and Missiles

You've got to design to tougher specifications for combined shock and vibration isolation if you're going to protect the reliability of electronic controls in today's high-performance jets and missiles. Faster accelerations, zero-length launching, and extreme maneuverability combine to impose shock and vibration loads far beyond current MIL specs. *These severe operating conditions must be reduced to a predictable environment suitable for electronic equipment.*

Isolator Requirements

Higher shock inputs require more stiffness in the isolator, to store more energy for a given deflection, so there will be less energy to dissipate if the isolator bottoms. *Higher vibration amplitudes* call for greater clearances and minimum transmissibility at resonance. And vibration protection *under high-g sustained acceleration* demands a combination of these characteristics.



Use of Performance Curves

The characteristics of an isolator having the stiffness necessary for handling the shock and sustained accelerations of jet and missile take-offs is shown by the curves of Figure 1. These curves can be used in choosing the proper isolator for operation under the expected service conditions, since they show both the deflection of isolators under a wide range of loadings and the maximum allowable deflection due to the combination of static load, sustained acceleration, and vibration amplitude.

A transmissibility at resonance well below three — considered exceptionally low — is shown by the curves of Figure 2. The measurements for these curves were made with a 27-pound load supported on four 10-pound isolators, with double-amplitude vibration input of 80 mils. These curves, showing performance for both base and bulkhead mounting, also indicate that the isolator satisfies the need for *consistent operation in every attitude* of flight, launching, and maneuvering.

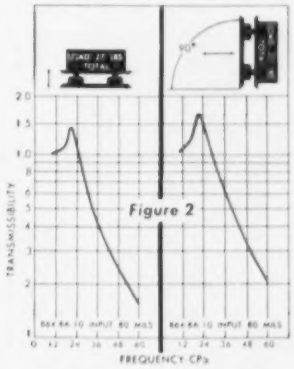


Figure 3 illustrates the construction of the B64 isolator that provides the performance characteristics shown by the curves, yet is dimensionally interchangeable with MIL-size mounts of comparable load ratings.

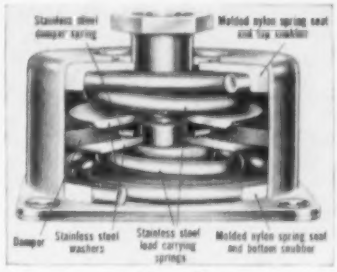

Stainless steel damper spring
Molded nylon spring seat and top snubber
Damper
Stainless steel washers
Stainless steel load carrying springs
Molded nylon spring seat and bottom snubber

Figure 3

Sustained Acceleration

The following example shows how Figure 1 aids in the choice of an isolator to give vibration protection under sustained acceleration. The straight part of the curves shows that the working range for each isolator allows about 190 mils maximum deflection (for axial loads). This occurs at about three times the maximum load rating of the isolator. So a fully loaded isolator will withstand about three g's before bottoming (clearance in the Barry ALL-ANGL isolator is about 200 mils from the no-load position).

ALL-ANGL Barry Mounts protect vital fuel-gaging-system power units under acceleration of 6 g vertical and 5 g horizontal.

For operation under steady-state accelerations, the ratio of actual load to maximum-load rating must be decreased. Thus, for a 6-g acceleration, a five-pound isolator would bottom at an actual load of 2.5 pounds, or a 40-pound isolator would bottom at an actual load of 20 pounds.

Vibration Protection

Because it is necessary to allow for the deflection due to applied vibration, ALL-ANGL isolators are often used at loads below their maximum ratings. For example: assume a 40-pound isolator loaded at 15 pounds and required to withstand 4 g's. From the curve, the 60-pound force corresponding to 4 g's will produce a 110-mil deflection. Since this is 80 mils below the 190-mil allowable maximum, a double-amplitude vibration input of 80 mils can easily be handled. This is a conservative application which allows for possible resonant conditions.

Because natural frequency increases as the isolator loading decreases, the final choice must take into consideration the relative importance of steady-state loading, vibration isolation, and shock protection. All of these factors are evaluated in engineering data available from Barry Controls Incorporated.

Additional Design Data

Other curves of isolator characteristics, and data on their use in designing *for predictable environment in jets and missiles*, are contained in Barry Bulletin 57-2. This bulletin fully describes the complete line of ALL-ANGL Barrymount isolators in standard MIL sizes. Write today for your free copy.

•

Barry's new Western Division, in Burbank, California, offers fast, on-the-spot design and prototype service, and production of special systems.

•

BARRY CONTROLS INCORPORATED

BARRY B MOUNT

SALES REPRESENTATIVES IN ALL PRINCIPAL CITIES

707 PLEASANT STREET, WATERTOWN 72, MASSACHUSETTS

in the second. Total electronics spending for the first half reached over $1.5 billion.

The RETMA figures include that portion of military expenditures for electronics from such major defense procurement categories as aircraft, ships, combat vehicles, guided missiles, electronics and communications, and research and development. They are intended primarily to be used to depict trends, and subject to later revision. The trend in each category is shown in the chart.

► **Rise** — Percentage-wise, the $353.0 million expended for aircraft electronics represents a 39.1-percent portion of the total spent for electronics in the second quarter of the fiscal year.

In the first quarter, 33.7 percent of the electronics budget went for aircraft electronics.

In the electronics and communications field, the $236.0 million spent by the Defense Department in this category for electronics represents 26.1 percent of the total spent for electronics in the second quarter, an increase of about six percent over the amount expended in the first quarter.

For guided missiles, 23.9 percent, or $216.0 million, of the total spent for electronics was expended during the second quarter, compared to nearly 33 percent in the first quarter.

FCC Actions

► **Decided** to study frequency allocations between 25 and 890 mc for the first time since 1944. This will supplement current vhf-uhf tv survey

► **Added** fourth vhf to Miami, a third vhf each to Charleston, S. C., Duluth-Superior and Norfolk-Portsmouth-Newport News areas

► **Received** petition from transit-mix concrete group for more frequencies in the region from 152 to 162 mc

► **Designated** hearing for AT&T and RCA Communications relative to radiotelephone service between San Francisco and Hawaii. AT&T requests renewal; RCAC wants a new station

► **Considered** tariff schedules applicable to off-air pickup and relay for television programs

► **Took** request to permit railroads to furnish radio communication to transportation services under contract now in existence

► **Received** bid to liberalize radiation and power-line interference limits for one year on tv, f-m and other receivers

► **Asked** by users in petroleum radio service to allow sharing of 27 frequencies between 30.86 and 47.38 mc

► **Warned** prospective users of industrial, scientific and medical or radio operations against investment in equipment for 915 mc since reallocations may be effected

► **Continued** consideration of toll-tv

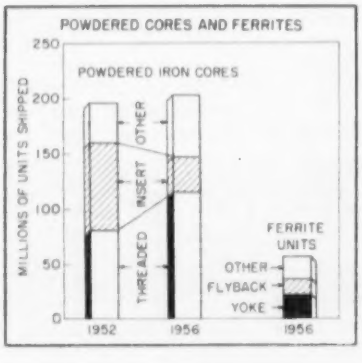
► **Revealed** total of 24 translators now on air, 17 grants and 54 pending

Magnetic Cores Add Volume, Ferrites Gain

Most core types show increase in sales. Ferrite figures now available

IN 1956 some 201-million powdered iron cores were shipped compared to 195 million in 1952.

In addition, the use of ferrites in electronics has also reached substantial proportions. Now the Metal Powder Association keeps score on how much is used each year. The first compilation, for 1956, shows that about 55-million ferrite units were shipped last year.



► **Core**—The bulk of the 200-million cores shipped last year to electronic manufacturers was made up of threaded and insert cores. Some 115-million threaded cores were shipped in 1956 compared to 80 million in 1952, practically a 50-percent increase in volume.

(Continued on page 24)

NIXIE ELECTRONIC INDICATING TUBE

SEEING IS BELIEVING

WIDE VIEWING ANGLE

PERFECTLY FORMED NUMBERS — PRECISELY ALIGNED

ALL ELECTRONIC — NO TORQUE LIMITATIONS

CONTROLLABLE BRILLIANCE

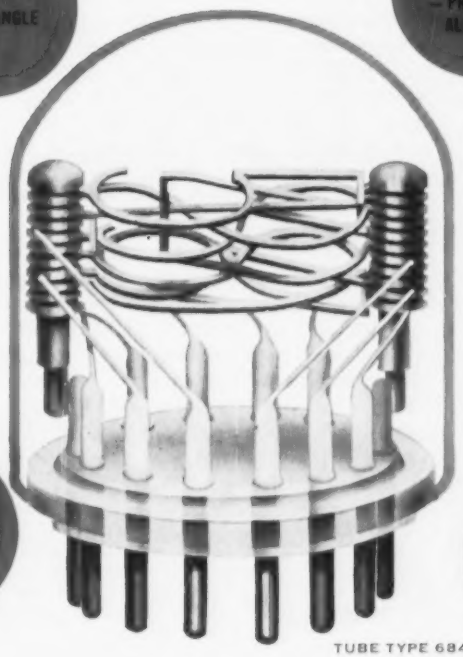
RUGGED CONSTRUCTION

LONG LIFE

MINIMUM VOLUME FOR GIVEN NUMBER SIZE

SIMPLE PLUG-IN STEM HIDDEN TUBULATIONS

SIZE 1" x 1"



TUBE TYPE 6844

SOME TYPICAL NIXIE APPLICATIONS

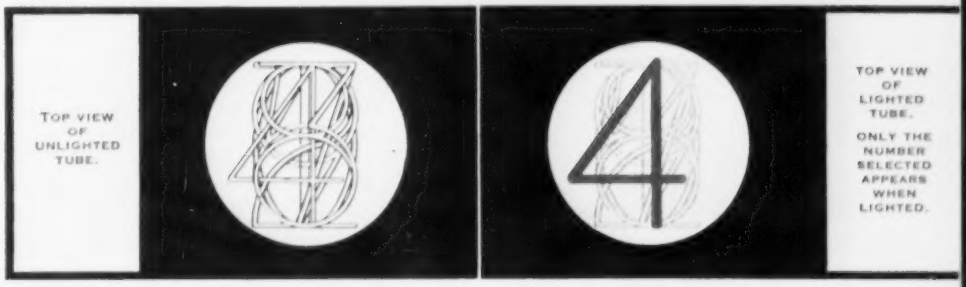
1. INDUSTRIAL CONTROL
2. INSTRUMENTATION
3. COUNTERS
4. COMPUTERS
5. MILITARY ELECTRONIC INDICATORS
6. CHANNEL INDICATOR
7. INDICATOR BOARDS
8. DIGITAL VOLTMETERS
9. PAGING SYSTEMS
10. ELEVATORS
11. RADAR

ANY NUMBER SELECTED IS INSTANTLY READABLE

The first mass-produced all electronic readout tube . . . **NIXIE IS NOW IN VOLUME PRODUCTION** at the Burroughs Corporation Electronic Tube Division . . .

NIXIE is a gas-filled, cold cathode tube which contains all the numerical digits 0 to 9, any individual number can be simply selected and displayed in a common viewing area, the ideal method for converting electro-mechanical or electronic signals directly to readable characters.

NIXIE Design Advantages include: Unlimited Rate of Change. Lowest cost in-line Indicator. Lowest Power in-line Indicator. Operation Unaffected by Temperature Changes. Multiple Remote Indications From One Driving Circuit. Production Uniformity From Tube to Tube and Number to Number. Human Engineered for Performance, Appearance, and Reliability.



Electronic Tube Division

BURROUGHS CORPORATION

Plainfield, New Jersey

Insert cores, which represented a volume of 80 million in 1952, dropped about 30 million last year. Insert cores are those in which a metal insert is molded cemented in one or both ends.

Other core shipments in 1956 totaled 55 million units. The figure tuning cores which are side or end molded iron cores for continuous permeability tuning with an insert cemented or molded into it, the coil form which is an iron core formed with wire leads at both ends, and special and miscellaneous types of cores.

▶ **Ferrites**—Of the 55-million ferrite units shipped last year, about 20 million went into yokes and some 12 million into flyback cores. The remainder went into miscellaneous uses including applications where pondered iron cores are used.

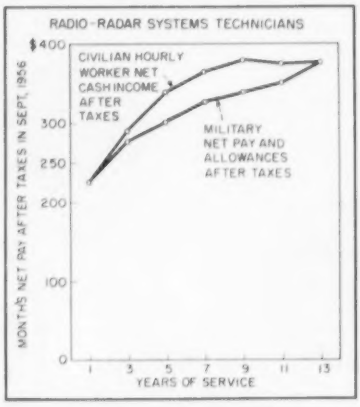
▶ **Growth**—Importance of metallurgy in electronics is indicated by the growing number of electronics manufacturers who have become part of the Metal Powder Association. Today over 15 companies in the field are members compared to nine two years ago. MPA holds its 13th annual meeting and the 1957 Metal Powder Show April 30 and May 1 in Chicago.

Radar Tracks in 3D

Plug-in type computer uses printed circuits, 1,500 transistors and 11,000 diodes as part of radar track-while-scan system that automatically tracks up to 72 targets in three dimensions. Developed by Westinghouuse, the system presents three-dimensional information from a single-radar source

Whats Behind Military Turnover?

MILITARY services have been unable to retain the people they train long enough for them to gain the experience required to meet the qualitative needs of the services. This is especially true in the military electronics field. To help, Defense Secretary Wilson organized the Defense Advisory Committee On Professional & Technical Compensation. The chart represents part of the study and conclusions of the committee.



▶ **Why** — As the graph indicates, military compensation for radio-radar systems technician with three dependents compares favorably for the beginner and stays fairly close to the civilian hourly worker during the first few years. The gap begins to widen at the point of decision on reenlistment.

The chart shows that regardless of dependency status, the serviceman concluding his first tour of duty can normally expect higher pay and greater promotional opportunity in a starting civilian job.

The study also showed that in the new expanding technologies such as electronics where skilled manpower is at a premium, there are greater than normal opportunities available, and young workers can expect to progress rapidly.

Console Guides Airborne Missiles

CENTRAL control point for ground piloting the X-10 and other Navaho test vehicles in North American's missile pilot console. An f-m/f-m radio-command system, the console enables continuous control: take-off, turns, pitch and landing.

Coder permits simultaneous sending of 30 different signals over one frequency. Weight and size of receiving equipment is reduced by half.

Standard installation incorporates two uhf transmitters which share a common antenna. A carrier guardian circuit monitors the output of each transmitter, and automatically shifts transmitters if trouble should develop in one. Energy is radiated by an omnidirectional, circularly polarized antenna.

Dials show telemetered information from in-flight X-10 or other Navaho test vehicle while controls direct flight

▶ **Rates** — On-off commands are coded by controlling the repetition rate of each subcarrier and the possible combinations of repetition rates of the two subcarriers. When no switch commands are actuated, each subcarrier is deviated at a repetition rate of 100 cps. This combination establishes home position, or condition of no command in airborne decoder.

A total of 29 available on-off commands and a home position satisfy the requirements for flight

NOW...200, 300, 400 & 500 AMPERE

DC POWER SUPPLIES

with wide continuously adjustable

24 TO 32 VOLT RANGE

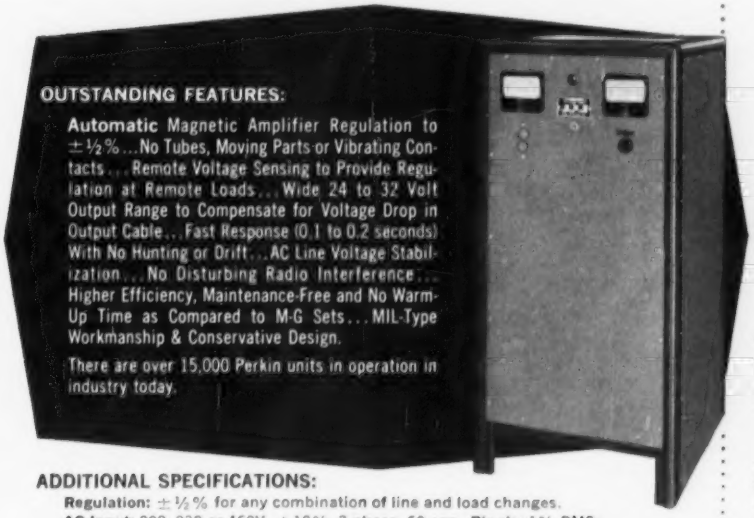
by PERKIN!

APPLICATIONS:

- Centralized Laboratory or Plant DC Power. • Missile Check-Out and Launching
- Aircraft Engine "Soft" Starting and Testing. • Battery Charging & Standby Service

...and other heavy duty 28 volt DC Power applications.

immediate delivery!



OUTSTANDING FEATURES:

Automatic Magnetic Amplifier Regulation to ±½%...No Tubes, Moving Parts or Vibrating Contacts...Remote Voltage Sensing to Provide Regulation at Remote Loads...Wide 24 to 32 Volt Output Range to Compensate for Voltage Drop in Output Cable...Fast Response (0.1 to 0.2 seconds) With No Hunting or Drift...AC Line Voltage Stabilization...No Disturbing Radio Interference...Higher Efficiency, Maintenance-Free and No Warm-Up Time as Compared to M-G Sets...MIL-Type Workmanship & Conservative Design.

There are over 15,000 Perkin units in operation in industry today.

ADDITIONAL SPECIFICATIONS:

Regulation: ±½% for any combination of line and load changes.
AC Input: 208, 230 or 460V, ±10%, 3 phase, 60 cps. **Ripple:** 1% RMS.
All units available with dollies for mobility.

AVAILABLE MODELS:

MR2432-200A, 200 amps • MR2432-300A, 300 amps • MR2432-400A, 400 amps
MR2432-500A, 500 amps

When you require a power supply, SPECIFY PERKIN, for a wider range of standard models and immediate delivery from stock.

Wire factory collect for prices. For a prompt reply on your application, write factory on your letterhead.

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PERKIN ENGINEERING CORPORATION

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Leader in Tubeless Magnetic Amplifier Regulation

Immediate Delivery on standard models available from factory and:
New York area office: Sales and Warehousing: 1060 Broad St., Newark 2, N.J., MArket 3-1454
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OTHER PERKIN STANDARD DC POWER SUPPLIES

28 Volt Models

Model	Volts	Amps	Reg.	AC Input (60 cps)	Ripple rms
28-5VFM	0-32 V	5	15-20% (24-32V range)	115 V 1 phase	2%
28-10WX	24-32 V	10	±½%	100-125 V 1 phase	1%
MR532-15A	2-36V	15	±½%	105-125V 1 phase	1%
28-15VFM	0-32 V	15	15-20% (24-32V range)	115 V 1 phase	5%
M60V	0-32V	25	±1%	115V 1 phase	1%
MR1040-30A	5-40V	30	±1%	100-130V 1 phase	1%
28-30WXM	24-32V	30	±½%	100-125V 1 phase	1%
28-50WX	24-32 V ±10%	50	±½%	230 V* 3 phase	1%
MR2432-100XA	24-32V	100	±½%	208/230V* 3 phase	1%
MR2432-200	24-32 V	200	±½%	208/230V* 3 phase	1%
MR2432-300	24-32 V	300	±½%	208/230V* 3 phase	1%
MR2432-500	24-32 V	500	±½%	208/230V* 3 phase	1%

*±10%. Also available in 460 V ±10% AC input. Will be supplied with 230 V input unless otherwise specified.

6, 12, 115 Volt Models

	Model	Volts	Amps	Reg.	AC Input (60 cps)	Ripple rms
6 Volt	6-5WX	6 ±10%	5	±1%	95-130 V 1 phase	1%
6 Volt	6-15WX	6 ±10%	15	±1%	95-130 V 1 phase	1%
6 Volt	6-40WX	6 ±10%	40	±1%	95-130 V 1 phase	1%
12 Volt	12-15WX	12 ±10%	15	±1%	95-130 V 1 phase	1%
115 Volt	115-5WX	115 ±10%	5	±½%	95-130 V 1 phase	1%
115 Volt	MR1512S-5	15-125	5	±1%†	95-130 V 1 phase	1%††
115 Volt	G125-25**	115-125	25	±1½-4%	230/460 V 3 phase	5%

**Germanium Rectifier Unit ††Increases to 4% @ 15V.
†Increases to 2% @ 15V.

test of the missile, as well as for recovery and range safety.

Telemetering equipment reports to the ground the strength of the signal the missile is receiving. When the signal fades due to distance, the ground operator turns the vehicle over to a control center nearer the missile.

Financial Roundup

Company	Net Profit 1956	1955
Admiral 12m	$1,037,274	$3,932,144
American Bosch 12m	4,626,357	3,383,568
ACF 9m	5,958,404	6,005,910
ANF 12m	8,621,000	4,408,000
Burroughs 12m	14,197,021	11,831,504
Clarostat 12m	227,924	164,234
Consolidated Electro 12m	1,283,263	803,696
DuMont 12m	*3,887,000	*3,674,000
Emerson 12m	84,852	2,468,063
Fansteel 12m	3,366,323	2,298,195
General Electric 12m	213,800,000	208,900,000
High Voltage 12m	167,852	106,452
Hoffman 12m	1,691,974	1,560,596
Indiana Steel 12m	764,336	766,945
Kintel Products 12m	227,673	*6,254
Minnesota Mining 12m	38,437,684	34,323,370
Motorola 12m	7,966,817	8,490,539
Philco 12m	399,000	
RCA 12m	40,031,000	47,525,000
Servomechanisms 12m	615,606	441,367
Sprague Electric 12m	2,476,297	3,003,128
Stewart Warner 12m	6,632,399	6,163,217
Sylvania 12m	13,706,189	13,812,970
Texas Instruments 12m	2,349,103	1,581,790
Tung Sol 12m	2,909,397	106,452
Zenith 12m	6,178,717	8,634,191

* Loss

Soldering Irons Build Computers

Nearly 500 small GE soldering irons of the type shown are used to solder about a half-million joints needed to make one IBM 705 function. Joints soldered in the magnetic core memory unit alone total nearly 9,000

Meetings Ahead

Apr. 29-May 1: Third National Flight Test Instrumentation Symposium, ISA, Statler Hotel, Los Angeles.

Apr. 29-May 3: 81st SMPTE Convention, Shoreham Hotel, Washington, D. C.

May 1-3: 1957 Electronic Components Symposium, Morrison Hotel, Chicago, Ill.

May 7-9: Eleventh Annual Frequency Control Symposium, U. S. Army Signal Engineering Labs, Berkeley-Carteret Hotel, Asbury Park, N. Y.

May 9-10: 1957 PGMTT Meeting, Western Union Auditorium, New York, N. Y.

May 12-16: The Electrochemical Society 111th Meeting, Hotel Statler, Washington, D. C.

May 13-15: National Aero & Navigational Electronics Conference, IRE, Dayton, Ohio.

May 14-16: Industrial Nuclear Technology Conference, ARF, Ill. Tech, Nucleonics Magazine, Museum of Science and Industry, Chicago, Ill.

May 15-16: Age of Space Symposium sponsored by Southern Research Institute, Birmingham, Ala.

May 16-18: New York State Society of Professional Engineers, 1957 Engineering Industries Exposition and Annual Convention, Statler Hotel, New York, N. Y.

May 20-23: 1957 Electronic Parts Distributors Show, Conrad Hilton Hotel, Chicago, Ill.

May 22-25: URSI Spring Meeting, Hotel Willard, Washington, D. C.

May 27-29: 1957 National Telemetering Conference, AIEE, ISA, IAS, Hotel Cortez, El Paso, Texas.

June 6-7: First National Symposium On Production Techniques, IRE, Willard Hotel, Washington, D. C.

June 10-11: Second RETMA Symposium On Applied Reliability, Mature Design/Reliable Design, Hotel Syracuse, Syracuse, N. Y.

June 17-19: First National Meeting Of PGMIL of IRE, Sheraton Park Hotel, Washington, D. C.

June 19-21: Twelfth Annual Meeting, Association For Computing Machinery, University Of Houston, Houston, Texas.

June 27-29: Thirteenth annual meeting, Institute Of Navigation, Sheraton-Park, Hotel, Washington, D. C.

June 27-July 1: British IRE Convention, "Electronics In Automation", University of Cambridge, England.

Aug. 20-24: 1957 WESCON, IRE, WCEMA, Cow Palace, San Francisco, Calif.

Industry Shorts

► **Noncommercial** educational tv stations on the air now number 24, according to the Joint Council On Educational Television. Seven more stations are expected on the air during the year.

► **Sales** of special-formula waxes made by Dennison Manufacturing for use in the production of transistors are rising steadily. Waxes are used to hold germanium metal in position during precision machining of the metal into transistor crystals. The material is not carried in inventory because production techniques in electronics change too rapidly, according to the company.

► **Electronic** color photography system that would provide permanent prints of pictures taken less than five seconds earlier at points thousands of miles away is foreseen by Irving Wolff of RCA.

► **Weather Bureau** awarded a 1.2-million contract to Servo Corp. to develop a radiotheodolite for automatically tracking a balloon-born radiosonde transmitter of 50 milliwatts for a distance of 100 miles.

NEW!

KAY Mega-Sweep

MODEL MARKER

NOW—A Kay MEGA-SWEEP with markers

Basically, the *MEGA-SWEEP, MODEL MARKER* is a *Mega-Sweep*, 111-A. In addition, the unit employs harmonics of a crystal-controlled oscillator at 5 mc and 50 mc to provide two series of marks at harmonic frequencies over the entire range of the *Mega-Sweep*. The crystal calibrators may be switched to either 5 mc or 50 mc; the 5 mc crystal may be used to measure bandwidth, the 50 mc frequency crystal may be used for determining center frequencies.

FEATURES

- A broad-band high frequency sweeping oscillator with built-in crystal calibration.
- Combines flexibility of Mega-Sweep with accuracy of harmonic crystal oscillator.
- Meets the demand for accurate high frequency band pass alignment.
- Provides continuously variable sweep widths and center frequencies from 50 Kc to 40 mc.
- Provides crystal-controlled birdie type marks over the entire range.

See us at the Armed Forces Communications & Electronics Convention

May 20-22 Washington, D. C. Booth 46

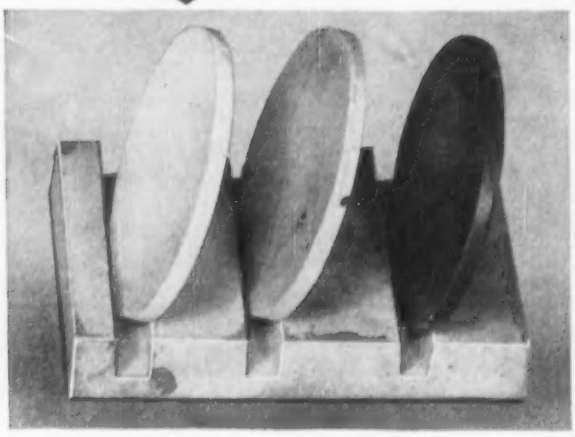
SPECIFICATIONS

FREQUENCY RANGE: Two bands; 10-500 mc and 400-950 mc.
SWEEP WIDTH: Continuously variable 50 Kc-40 mc.
SWEEP RATE: Variable around 60 cps. Locks at line frequency.
RF OUTPUT VOLTAGE: High—approx. 0.15 volts rms into nom. 70 ohms. Low—approx. 0.07 volts rms into nom. 70 ohms.
AMPLITUDE MODULATION: Less than 0.1 db/mc over frequency sweep.
OUTPUT WAVEFORM: Less than 5% harmonic distortion at full output. Less than 2% at half output.
RF OUTPUT CONTROL: Uncalibrated microwave attenuator, continuously variable to 26 db. Attenuation characteristic flat over output frequency range.
FREQUENCY MEASUREMENTS: By use of a precision micrometer-controlled wavemeter, the mid-point frequency of sweep may be pre-set or frequency at any point on oscilloscope display determined to within ± 5 mc.
SWEEP VOLTAGE: Regular sawtooth approx. 20 volts.
DIMENSIONS: 10½" x 18½" x 14½".
POWER SUPPLY: Input approx. 110 watts, 117-V (± 10%), 50—60 cps. ac. B+ electronically regulated.
CRYSTAL CALIBRATOR OUTPUT: Mixed directly with output of Mega-Sweep.
OSCILLATORS: Internally coupled providing a marker demonstration directly on sweep.
STABILITY: Maintained through electronically regulated power supply.
ACCURACY: Crystal—±.01%.
CRYSTAL CALIBRATOR FREQUENCY: Fundamental at 5 mc and 50 mc.
HARMONICS: Over whole of usable swept range of Mega-Sweep.
WEIGHT: 45 lbs.
PRICE $745.00 F.O.B. Pine Brook, N. J.

FOR COMPLETE DETAILS
REGARDING OTHER KAY INSTRUMENTS, WRITE:

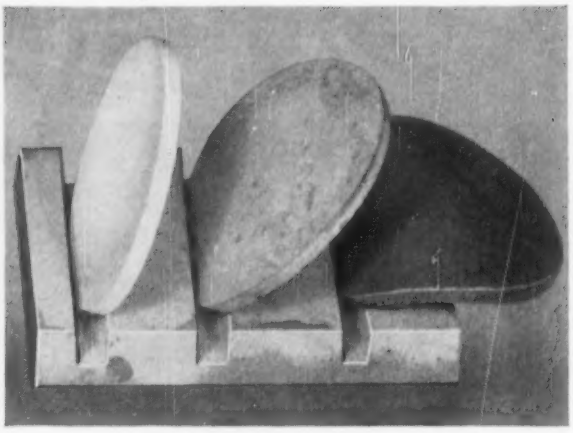
KAY ELECTRIC COMPANY

Dept. E-5 14 Maple Avenue, Pine Brook, N. J. CAldwell 6-4000



START OF SLUMP TEST

SUPRAMICA* 560 ceramoplastic insulation (Left) is to be compared with SUPRAMICA* 555 ceramoplastic (Center) and MYCALEX 410* glass-bonded mica — the best available materials with comparable properties.



30 MINUTES AT 550°C

SUPRAMICA 560 is unaffected — SUPRAMICA 555 shows a slight tendency to slump — MYCALEX 410 shows a marked slump.

SUPRAMICA* 560 ceramoplastic

LIGHTWEIGHT MATERIAL CAN BE MOLDED WITH FRAGILE INSERTS

SUPRAMICA 560 ceramoplastic will free your designs from many of the functional limitations imposed by conventional insulating materials. Manufactured exclusively by Mycalex Corporation of America, SUPRAMICA 560 has the electrical and physical properties to meet exacting high-temperature insulation specifications — **in applications where no other material can be used!**

Proof of this high temperature performance is shown by these unretouched photographs of an actual "slump" test (Above). The characteristics listed at the right demonstrate the versatility of SUPRAMICA 560 ceramoplastic.

Lighter in weight than any comparable material — specific gravity similar to that of aluminum or mineral-filled polyesters — SUPRAMICA 560 is the perfect insulation for relay bases, connectors, tube sockets and many other parts in high-temperature components.

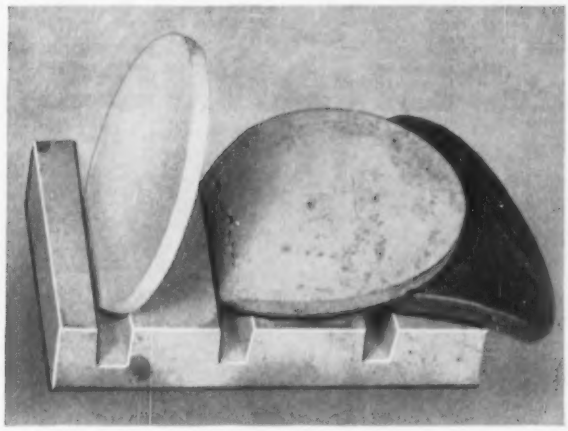
MYCALEX CORPORATION OF AMERICA precision molds this revolutionary new material for your product needs. Send for complete information.

SPECIFICATIONS: SUPRAMICA 560 ceramoplastic

DISSIPATION FACTOR, 1 MEG.	0.003
DIELECTRIC CONSTANT, 1 MEG.	6.8
LOSS FACTOR, 1 MEG.	0.020
VOLUME RESTIVITY, OHM-CM	$10.^{14}$
SPECIFIC GRAVITY	2.8 (Comparable to Aluminum or Mineral-Filled Polyester)
SAFE OPERATING TEMP.	
CONTINUOUS	500°C
SHORT-TIME	600°C
WATER ABSORPTION	NIL
HARDNESS, ROCKWELL M	125
THERMAL EXPANSION	12.4×10^{-7} (Same as SAE 1010 Steel)
FLEXURAL STRENGTH, PSI	15,000
INSERTS	WILL ACCEPT ALL MOLDED-IN VARIETIES

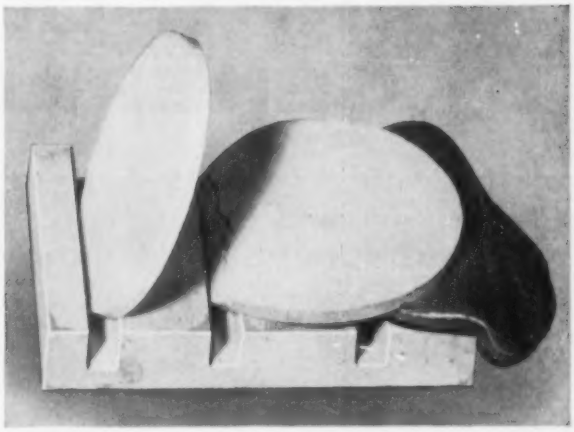
SUPRAMICA, MYCALEX

*SUPRAMICA, MYCALEX, and 410 are registered trade-marks of MYCALEX CORPORATION OF AMERICA.
555 is a trade-mark of the MYCALEX CORPORATION OF AMERICA.
SYNTHAMICA is a trade-mark of SYNTHETIC MICA CORPORATION, a subsidiary of MYCALEX CORPORATION OF AMERICA.



75 MINUTES AT 550°C

SUPRAMICA 560 remains unaffected — SUPRAMICA 555 has cracked and shows a definite slump — MYCALEX 410 shows foaming and complete slump.

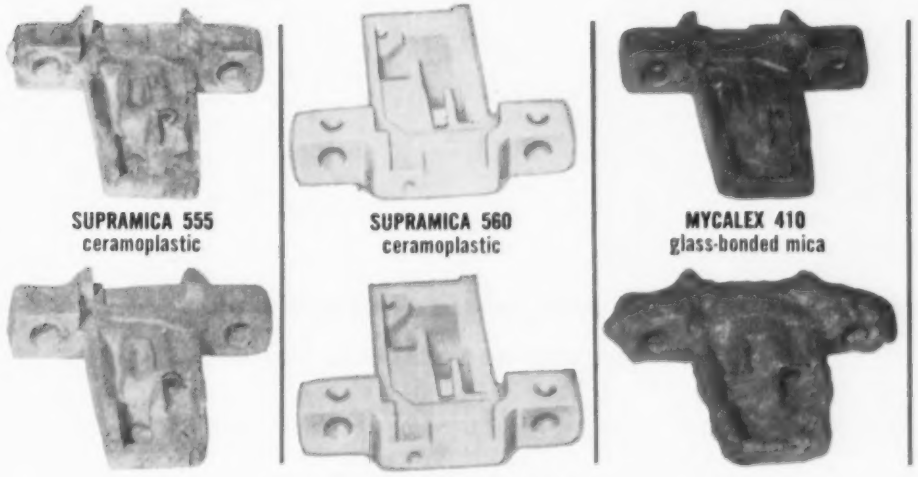


75 MINUTES AT 550° *PLUS* 15 MINUTES AT 650°C

SUPRAMICA 560 ceramoplastic still shows NO NOTICEABLE EFFECT — SUPRAMICA 555 has completely cracked through — MYCALEX 410 has foamed and collapsed.

INSULATION FOR CONTINUOUS OPERATION AT 500°C

TEMPERATURE ENDURANCE TEST ON MOLDED COMPONENTS



SUPRAMICA 555 ceramoplastic

SUPRAMICA 560 ceramoplastic

MYCALEX 410 glass-bonded mica

BEFORE TEST

AFTER 75 MINUTES AT 550°C PLUS 15 MINUTES AT 650°C

DIMENSIONAL INCREASE DURING TEST

LENGTH 5.5%
WIDTH 4.1%

LENGTH 0.4%
WIDTH NO CHANGE

LENGTH 12%
WIDTH 18% FOAMING

MYCALEX
CORPORATION OF AMERICA

GENERAL OFFICES AND PLANT:
CLIFTON BOULEVARD
CLIFTON, NEW JERSEY

EXECUTIVE OFFICES:
30 ROCKEFELLER PLAZA
NEW YORK 20, NEW YORK

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CHICAGO — DAYTON
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Solve core problems quickly, economically with

FERRITE COMPONENTS by GENERAL CERAMICS

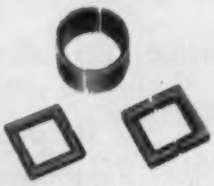
HUNDREDS OF STANDARD PARTS
plus CUSTOM DESIGNING TO SPECIFICATIONS

STANDARD ANTENNA RODS

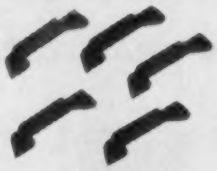
THREADED TUNING CORES

STANDARD EI CORES

CUP AND TOROID CORES



TELEVISION COMPONENTS



RECORDING HEADS

Computer and Automation Systems Designers!

Ferramic memories provide a new design concept in the area of computers and automation. Magnetic memories combine increased speed, accuracy and reliability with light weight, compact size. Write for bulletins on cores or complete memory planes.

Performance proven magnetic ferrites available for every electronic application

General Ceramics ferrites for television, radio and instrumentation offer designers and engineers a wide range of economical standard components. All are application tested for highest efficiency electrically and mechanically. The fact that leading electronic manufacturers specify Ferramics is due to the program of continuing research and equipment modernization by which General Ceramics keeps pace with the industry's needs as to quality *and costs!* Bulletins are available; write to General Ceramics Corporation, Keasbey, New Jersey, Dept. E.

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Industrial Ceramics for Industrial Progress...Since 1906

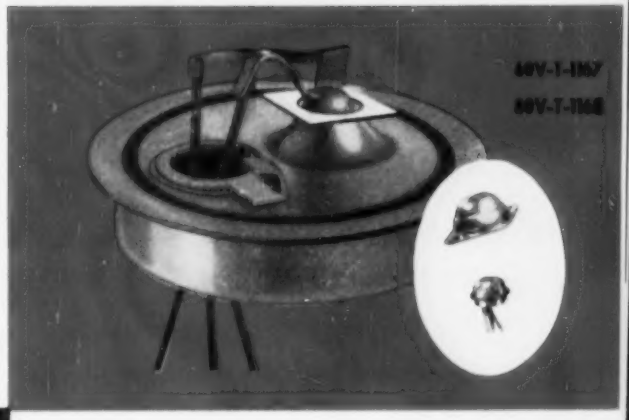
Manufacturers of FERRAMIC CORES, MAGNETIC MEMORY CORES, MEMORY PLANES, MICROWAVE FERRITES, SOLDERSEAL TERMINALS, HIGH TEMPERATURE SEALS, STEATITE, ALUMINA & CHEMICAL STONEWARE

New!.... FROM TRANSISTOR CENTER U.S.A.

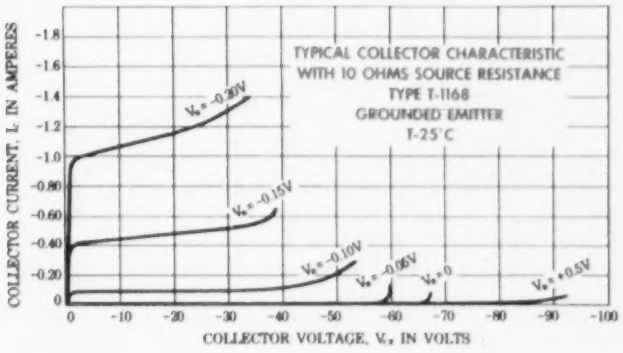
PHILCO 60V and 80V Power Transistors

Designed for servo, control, power converter and power supply applications.

Here are extremely reliable, moderately priced, high voltage power transistors—immediately available in production quantities. These transistors perform with a typical thermal drop of only 1½°C per watt . . . with storage temperature of 100°C. They have high beta at high currents . . . improved alpha cut-off . . . low surface leakage currents . . . low saturation resistance . . . low distortion. Both transistors operate at power load of 12.5 watts. The unique *knee-action* between the aluminum mounting clamp and the copper mount assures maximum dissipator contact at all times.



Philco cold-welding process permits hermetic sealing in controlled atmosphere... assuring exceptional transistor life and performance!



Philco transistors, after vacuum baking, emerge into a controlled atmosphere . . . where they are welded to insure perfect sealing for life. This process eliminates contamination of the transistor elements by moisture or atmosphere. Uniformity and quality control are strictly maintained throughout.

Write for complete data and prices. *Make Philco your prime source of information for power transistor applications!*

PHILCO CORPORATION

LANSDALE TUBE COMPANY DIVISION

LANSDALE, PENNSYLVANIA

for colors that last despite HEAT

BH "1151"

SILICONE RUBBER-FIBERGLAS SLEEVING

Silicone rubber insulations are recognized for their resistance to degradation under heat. But when color is introduced, many pigments react with the silicone to destroy the effectiveness of the insulation. With BH "1151" Fiberglas* Silicone Elastomeric Sleeving you have color and positive product protection. Whether you use Natural (Offwhite), Red, Yellow, Blue, Green, Brown, Orange or Violet, the superior insulation benefits are the same. And, with tracer stripes available in all colors, 64 combinations are at your command.

The precisely compounded coating of BH "1151" produces a Class "H" sleeving that easily meets MIL-I-18057 specifications. It offers product protection through a continuous operation range of -90°F. to 400°F., with no adverse effects from high spot soldering temperatures. The resiliency and strength of the sleeving permit expansion to cover irregularities and terminals.

Send for data sheets and production testing samples of BH "1151" . . . testing is believing!

BENTLEY, HARRIS MANUFACTURING COMPANY
1305 Barclay Street
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BENTLEY, HARRIS *Fiberglas** **SLEEVINGS**

*BH Non-Fraying Fiberglas Sleevings are made by an exclusive Bentley, Harris process (U.S. Pat. Nos. 2393530; 2647296 and 2647288). "Fiberglas" is Reg. T.M. of Owens-Corning Fiberglas Corp.

Want more information? Use post card on last page.

Electron Tube News —from SYLVANIA

Meeting industry's basic needs—everywhere in electronics

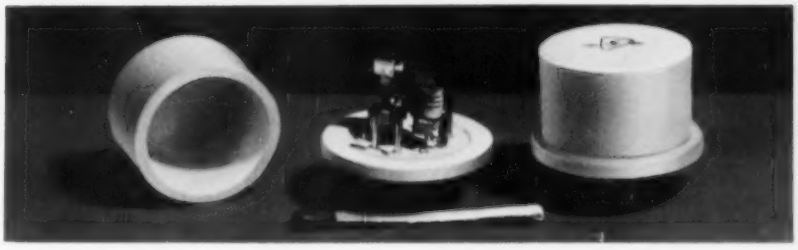
—IN STACKED TUBES

Sylvania and Industry team up to evaluate "Tubes of the Future"

Handmade samples of Sylvania stacked tubes are being made available to interested military equipment manufacturers. These potential users are conducting experiments which provide them with basic experience in the application of these radically new vacuum "tubes of the future."

In turn they are supplying Sylvania with analyses of their findings on the potential advantages of stacked tubes, their resistance to heat, shock, vibration, altitude and humidity. This teamwork, the interchange of data and ideas, will benefit the entire electronics industry. It will speed the full-scale availability of stacked tubes and make possible refinements in design which will take full advantage of the inherent potentials of the stacked tube.

Presently, experimental sampling includes single cathode double triodes and an audio power pentode. Development is underway to include double cathode dual section tubes and RF and audio pentodes in the basic complements planned for military application.



Internal view and completely assembled ceramic stacked tube.

Exploded view of stacked tube demonstrates its rugged planar mount construction utilizing ceramic element spacers assembled on a ceramic stem. Note that element spacings are independent of the tube envelope.

—IN TELEVISION

Type 6CZ5
for 110° vertical deflection

The Sylvania Type 6CZ5 is a beam pentode intended primarily for use as a vertical amplifier or audio amplifier and has controlled heater warm-up for series string operation.

Vertical Deflection Ratings
(pentode connection)

Plate V	315 V max.
Peak Positive Plate V	2200 V absolute max.
Plate Dissipation	10 Watts max.
Grid No. 2 V	285 V max.
Grid No. 2 Dissipation	2 Watts max.

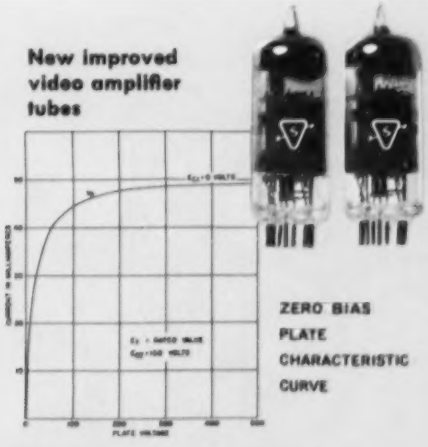
Type 6DQ6A
for 110° horizontal deflection

The type 6DQ6A has been upgraded for higher screen dissipation to meet the need for a horizontal deflection tube in 110° circuits. For series string circuits the type 12DQ6A features controlled heater warm-up time and 600 ma heater current.

Design Center Ratings

Peak Positive Plate V	6000 volts abs. max.
Plate Dissipation	15 W max.
Grid No. 2 Dissipation	3 W max.
Zero bias plate current	300 ma

New improved video amplifier tubes



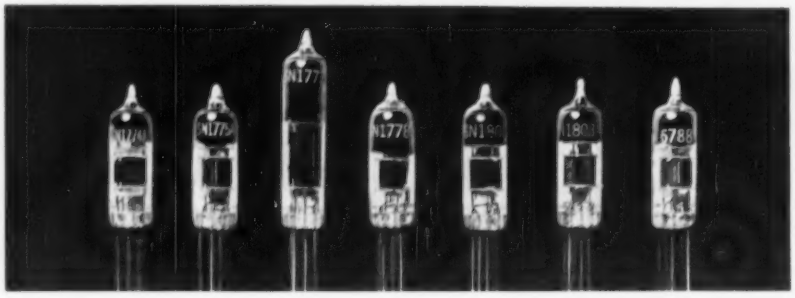
The sharp-cutoff pentode sections of the types 6AW8A and 6BA8A have been redesigned to exhibit a lower knee characteristic as shown in the graph. This permits a wider range of B+ supply voltages. In addition, pentode plates have been redesigned to increase dissipation from 3.0 to 3.25 watts.

Meeting industry's basic needs

—IN GUIDED MISSILES

New Guided Missile Line "giant step" in the evolution of tube reliability

Sylvania offers the first line of tubes specifically designed and tested for guided missile application to meet the industry's need for greater reliability where severe conditions of environmental temperature and vibration exist.



Visual inspection—visual inspection criteria as outlined in MIL-E-1C is applied to Guided Missile Tube production. This highly stringent and definitive spec helps to insure optimum reliability.

This line of tubes and the new levels of reliability it achieves represent the newest step in Sylvania's continuing program of tube reliability.

The Guided Missile Tube Line, developed under a Buship contract, is the result of thorough investigation of the missile field and emphasis in design has been placed on those tube parameters most critical to missile requirements.

Features of the line include new reliability tests such as "white noise," more severe flicker short tests, and more stringent fatigue test.

Of equal significance is the manufacturability of the Guided Missile Tube Line. It is capable of being mass produced on present facilities to meet military requirements in time of need.

7 types meet the basic requirements for Guided Missile applications

Sylvania exp. type	Description	Nearest Prototype
SN1774A	Sharp cutoff RF pentode	6205
SN1775A	Semi-remote cutoff RF pentode	6206
SN1776A (6788)	Pentode audio voltage amplifier	—
SN1777A	Audio beam power pentode	5902
SN1778A	Medium mu single triode	5977
SN1802A	Double, medium mu triode	6021
SN1803A	Double, high mu triode	6112

—IN FACILITIES

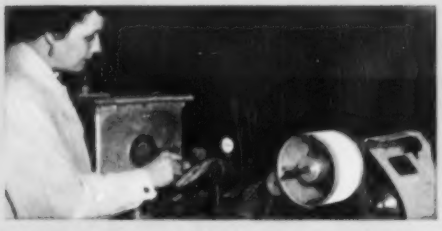
Subminiature plant combines "area cleaning" with "point cleaning" to help achieve greater tube reliability.

Sylvania's plant at Burlington, Iowa, is the most modern plant ever designed, built, and equipped for the exclusive production of "Gold Brand" premium subminiature tubes.

The recent installation of complete air conditioning and air purification adds a new measure of control in the manufacture of the world's most reliable tubes.

"area cleaning"—new installation of complete air conditioning and air filtering keeps areas, such as mounting department, relatively free from dirt and dust.

"point cleaning"—immediate work areas are kept spotlessly clean as in mount assembly. Air currents under hooded tables isolate the mounting area from outside air.



temperature control—plays an important factor in manufacturing processes, such as heater preparation. Makes it possible to control the manufacture of small diameter 26.5 volt heaters for maximum uniformity and dependability.

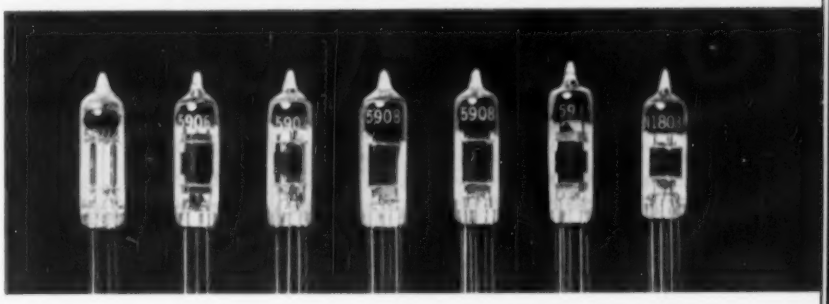
everywhere in electronics

—IN COMMUNICATIONS

New Subminiature Types for 26.5 Volt Systems

Sylvania now offers the designer a line of subminiature tubes designed with 26.5 volt heaters for systems operating from 26.5 volt power supplies. Mechanical and electrical design are combined with a proved quality control program to assure a high degree of reliability. "Burn-in" period before test improves the life expectancy rated at 5000 hours under life test conditions.

In addition to types rated for 26.5 volts on all elements, other types are provided for higher plate voltage operation. Thus the designer will find greater circuit design flexibility through appropriate selection of types to meet his equipment needs.



Type	Description	Heater Voltage	Plate Voltage
5903	Double diode with separate cathodes	26.5 V	Detector
5904	Medium Mu Triode	26.5 V	26.5 V
5905	Sharp cutoff RF pentode	26.5 V	26.5 V
5906	Sharp cutoff RF pentode	26.5 V	100 V
5907	Remote cutoff RF pentode	26.5 V	26.5 V
5908	Pentode mixer	26.5 V	26.5 V
5916	Pentode mixer	26.5 V	100 V

—IN CATHODE-RAY TUBES

Lightweight 17", 90° tube is TV's newest picture tube development

Following closely on the heels of the 110° picture tube, Sylvania announces a 17" tube with 90° deflection and standard neck diameter for portable TV application. The new 17" tube is three pounds lighter than the currently popular 17", 90° types.

Types are offered with either a 450 ma or 600 ma heater, for use with or without ion-trap. This new development makes it possible to design lighter portables while using readily available deflection yokes and existing circuitry.

see next page

New Flying Spot Scanner Tube

The new Sylvania Type 5BNP16 flying spot scanner tube is a typical development in Sylvania's rapidly expanding special purpose cathode-ray tube program.

It is an inexpensive tube with shorter overall length (10⅝"). It employs low voltage electrostatic focus, an aluminized screen, and operates without ion-trap for simplified installation.

SYLVANIA

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BUSINESS REPLY CARD

(First Class Permit No. 46687, New York 19, N. Y.)

SYLVANIA ELECTRIC PRODUCTS INC.
1740 Broadway
New York 19, N. Y.

Meeting industry's basic needs everywhere in electronics

—IN TUNER AND IF TYPES

6BN4

Medium mu triode designed for amplifier use in VHF tuners. Characteristics are similar to one section of the 6BZ7. 3BN4 and 2BN4 are series string versions with controlled heater warm-up.

6CY5

Sharp cutoff tetrode designed particularly for amplifier service in VHF tuners. Types 4CY5, 3CY5, and 2CY5 offer controlled heater warm-up for series string circuits.

6DK6

7-pin miniature sharp cutoff pentode. High transconductance at low plate and screen potentials make them especially useful as TV IF-amplifiers. Types 3DK6 and 4DK6 are series string versions.

—IN RECTIFIERS

Type 12DF5

The 12DF5 is a T6½ full wave rectifier with separate cathode connections and center tapped heater. Its ratings are comparable to the type 12BW4. Unique construction adds flexibility in rectifier or doubler use and permits operation from 6- or 12-volt heater supply.

—IN COMMUNICATIONS

Type 407A
Type 408A

Type 407A is a T6½ double triode with separate cathodes and a center-tapped heater for 20- or 40-volt operation. Its useful range extends to VHF for use as an amplifier, oscillator, multi-vibrator, or clamper.

Type 408A is a 7-pin, T5½ pentode for 20-volt heater operation. High Gm makes it desirable for amplifier service from audio through VHF ranges.

New Series String reference chart

Here is a chart designed to fit your notebook or hang conveniently on the wall. It is a complete listing of all 600 ma and 450 ma tube types designed for series string operation.

SYLVANIA

SYLVANIA ELECTRIC PRODUCTS INC.
1740 Broadway, New York 19, N. Y.
In Canada: Sylvania Electric (Canada) Ltd.
Shell Tower Bldg., Montreal

LIGHTING • RADIO • TELEVISION • ELECTRONICS • ATOMIC ENERGY

Please send additional information on the items checked below.

- ☐ 110° Deflection
- ☐ 6AW8A—6BA8A
- ☐ Guided Missile Line
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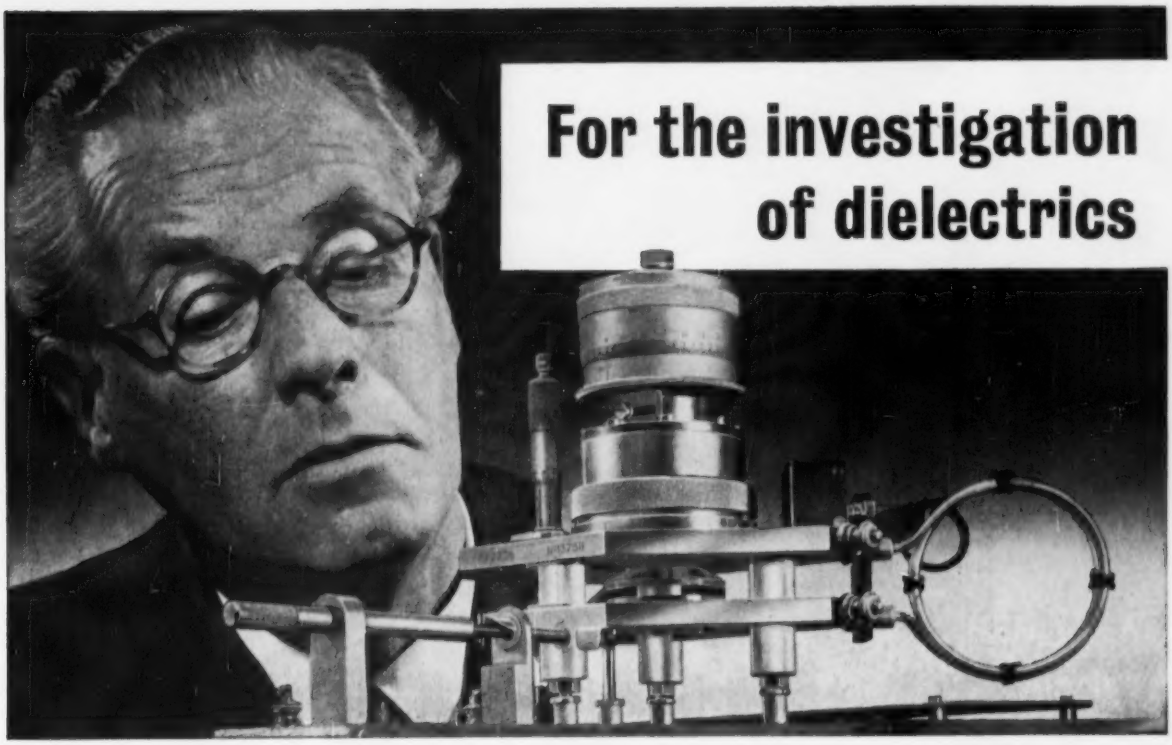
Use this handy business reply card to request additional information on these important new Sylvania developments



For the investigation of dielectrics

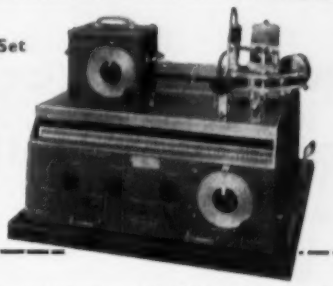
The MARCONI Dielectric Test Set *Type TF 704B*

The Marconi TF 704B Dielectric Test Set allows precise evaluation of the permittivity and phase defect of dielectric materials in the frequency range 50 kc to 100 Mc.

The principle of measurement is to introduce the sample under test into a tuned circuit and then, by means of a square-law voltmeter with high-discrimination mirror galvanometer, note the changes in circuit conditions.

The heart of the Test Set is the jig holding the sample under test. There is one jig for solid specimens and another for liquids. The jigs are masterpieces of the instrument maker's art; their high-quality construction is a blend of precision and ruggedness, which ensures accuracy and stability.

Dielectric Test Set Type TF 704B
The equipment includes two interchangeable oscillator units and a full range of jig loading coils.



In addition to the investigation of dielectrics, the high-frequency performance of resistors, capacitors, cables, etc., can be determined over a wide range.

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Marconi - since 1897

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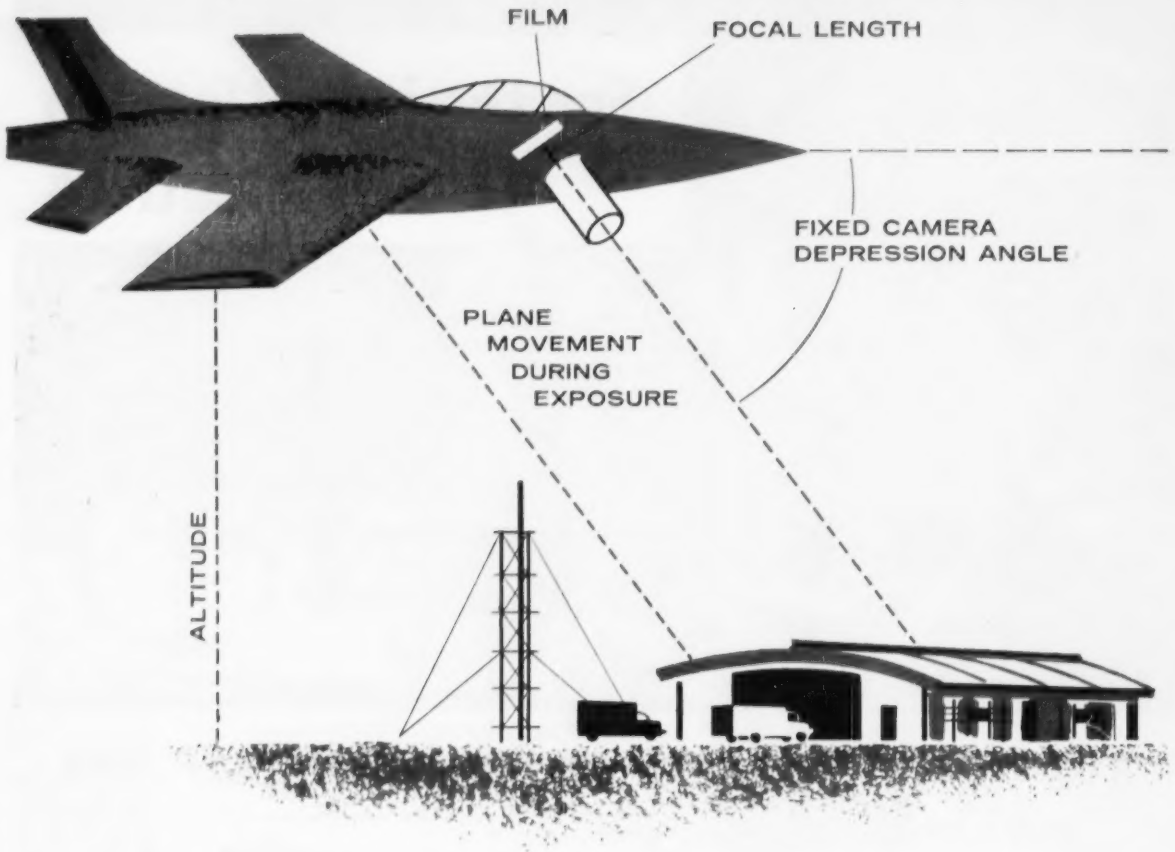

How Transicoil servos help aerial camera take clear stills even from low fast planes

It's one thing to take a picture of a moving object. But it's quite another to get good clear shots of the ground from low altitude aircraft moving at today's jet speeds. Universal Camera Control System (UCCS) is the latest development in aerial reconnaissance and photography to solve this problem. Designed and engineered by the Bill Jack Scientific Instrument Co., this novel system actually moves the film through the camera to compensate for image movement during the brief exposure time.

Accuracy of the system is dependent on the airborne DC analog computer having absolute dependability and precision under all the environmental conditions of aircraft flight. Extremes of altitude, temperature and vibration cannot impair its effectiveness.

Transicoil servo assemblies are used extensively in the computer to convert inputs of altitude, ground speed, camera depression angle, and focal length into the correct "film movement" signal.

The UCCS application is typical of the way Transicoil rotating components and complete servo assemblies are achieving high orders of accuracy and dependability in countless applications. Transicoil can solve your servo problems with comparable success. A Transicoil Sales Engineer can help you to get off to a good start. A letter from you outlining your servo problem will bring him to your desk.

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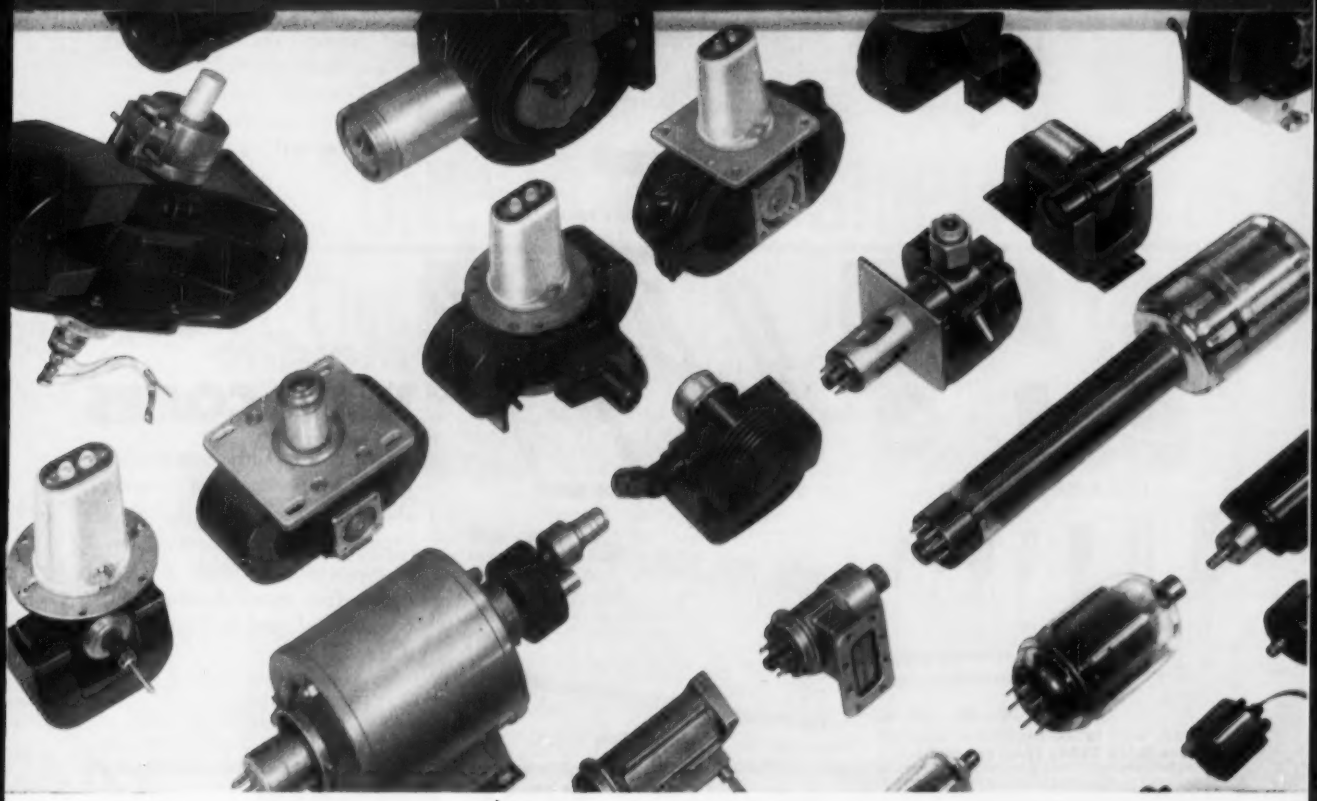

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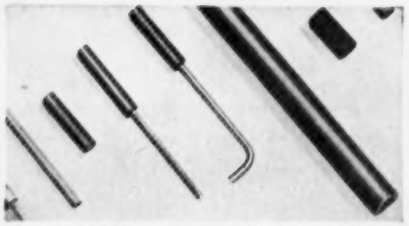
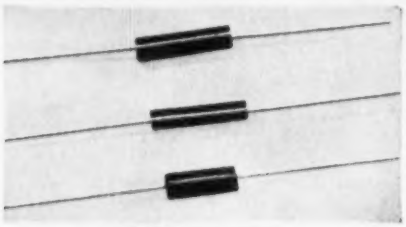


CORES, LOOP STICKS, SLEEVES, CUPS, TOROIDS, RODS

THREADED CORES



FERRITE COIL FORMS

Moldite FERRITES

offer these advantages:

- lower losses (eddy current)
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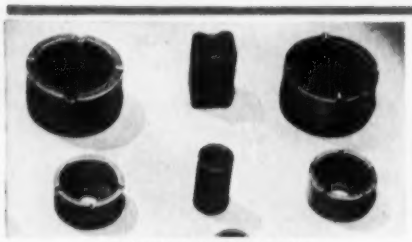
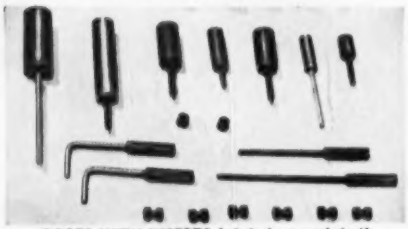
- lighter weight
- smaller sizes for more compact construction
- higher permeability
- less corona effect
- lower cost



IRON SLEEVE & CUP CORES

INSULATED IRON CORES



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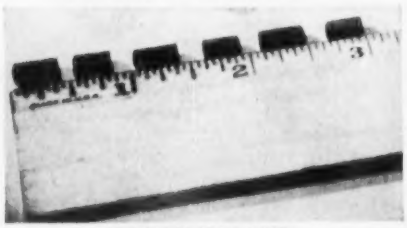

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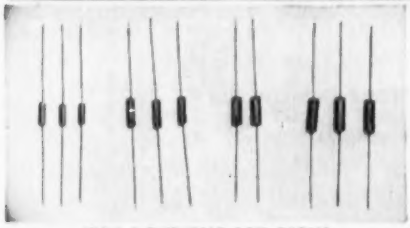
Moldite IRON CORES

Moldite Iron Cores are made in an infinite variety of powders, shapes, and sizes and include all types of standard cores as well as numerous specially designed cores for new developments, commercial and military applications.



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(also in ferrite)

Moldite COIL FORMS

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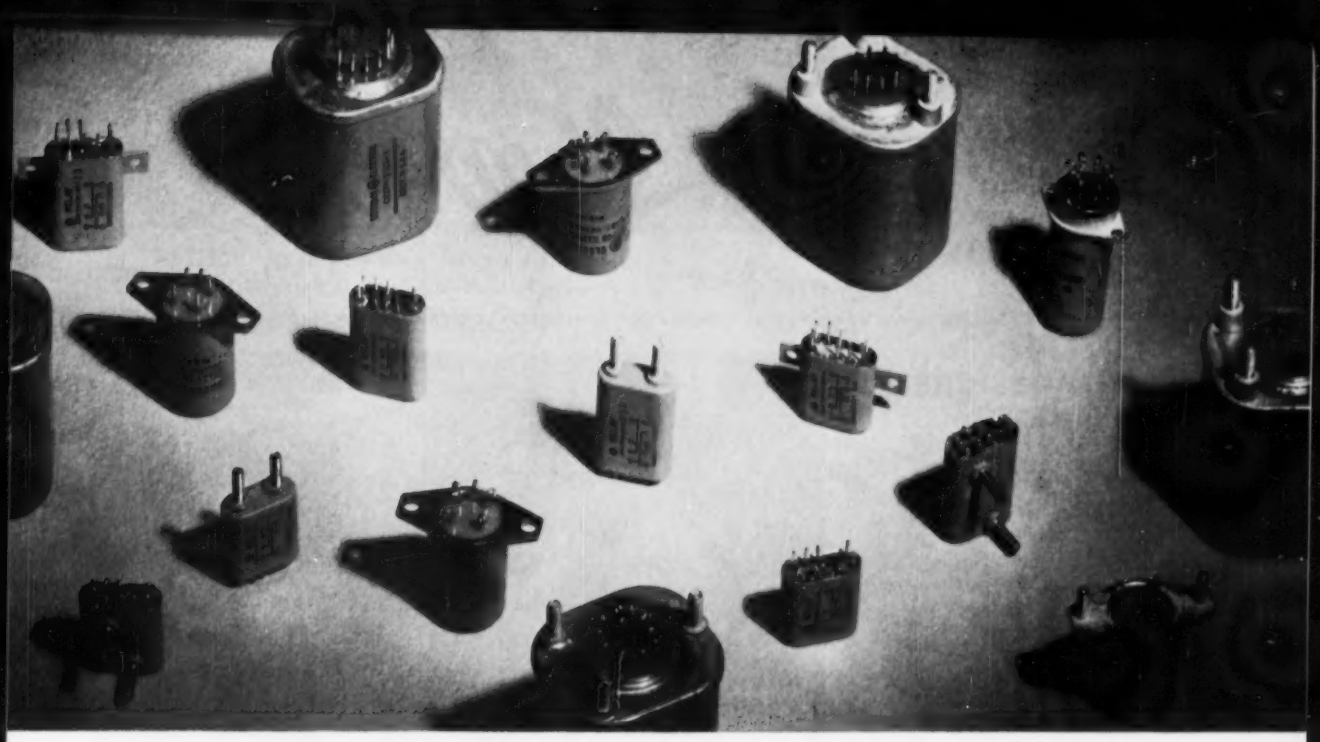

NOW . . . ONLY 3-WEEK SHIPMENT* on General Electric's full-line of sealed relays

Improved production techniques now make it possible for General Electric to offer its complete line of standard-listed hermetically sealed relays—including the amazing micro-miniature—*on only 3-week shipment from order date!*

And, what's more—General Electric is equipped to provide you rapid service on samples and prototypes.

FOR ALL ELECTRONIC SYSTEMS

G-E miniature, sub-miniature, and micro-miniature relays combine small size with unusual reliability under severe temperature, shock, and vibration conditions—making them ideal for all radio, radar, fire control, navigational equipment, and industrial electronics jobs.

Though initially designed for military applications, more and more G-E sealed relays are being used for industrial jobs. Their extreme reliability and small size now are utilized by industrial designers. Resistance welding and other industrial electronic circuitry is being simplified and miniaturized with G-E sealed relays.

WIDE RANGE OF COIL RATINGS, HEADER TYPES, AND MOUNTINGS

Whatever your small sealed relay needs—you'll find the answer with one of the many forms of these three models:

Miniature: Standard, current-sensitive, and voltage-sensitive models; in 2-, 3-, or 4-pole double-throw and 6-pole normally open forms. Rated 5 amps at 28 volts d-c at 85C. 3-amp make-before-break forms and 125C forms available.

Sub-miniature: 2 amps; .651 in. in diameter, 1.6 in. long; weighs one ounce. Unaffected by vibrations of 10 to 55 cps at .12 in. maximum excursion or 55 to 500 cps at 15Gs acceleration. Withstands shock tests in excess of 40Gs. Operates in ambients of 125C.

Micro-miniature: Weighs only 0.5 oz., measures .36 in. by .80 in. by .88 in. Rated 2 amp resistive at 28 v d-c or 115 v a-c. Also available in current-sensitive models. Standard relays withstand ambients of 125C and 20Gs acceleration at 50 to 500 cps. *Contact your G-E Apparatus Sales Office, or mail coupon. Specialty Control Dept., Waynesboro, Va.*

**Average shipment time for all standard-listed relays. Actual time: MICRO-MINIATURE (up to 100 units—2 weeks, 100 to 1000 units—4 weeks); SUB-MINIATURE (up to 100 units—3 weeks, 100 to 1000 units—5 weeks); MINIATURE (up to 100 units—1-2 weeks, 100 to 1000 units—3 weeks).*

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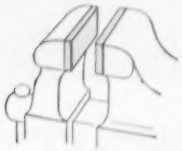
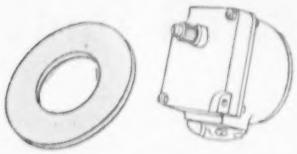
Tips for designers

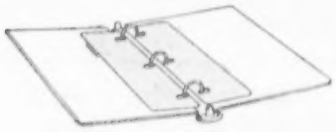
Back plate on an automobile headlight switch, punched and machined from Taylor Grade XP paper base laminate, has low moisture absorption and good dielectric strength.



Vise jaw caps, made of Taylor Grade C phenolic laminate, are easily cut and machined to shape. Marring of precision or delicate parts is eliminated.



Self-balancing servo motor has stator case insulator which is cold-punched from 1/64" thick Taylor Paper Base Phenolic Laminate sheet.



Flippers for loose-leaf binders are made of economical Taylor Vulcanized Fibre . . . affording added rigidity and good protection for the paper pages.

TAYLOR SUPERIOR COPPER-CLAD LAMINATES

Taylor GEC (glass epoxy) Copper-Clad and Taylor XXXP-242 cold punching (paper-phenolic) Copper-Clad. Taylor uses high purity rolled copper on base materials with outstanding electrical properties.

Time switch, made by the Tork Clock Co., uses two Taylor products . . . the deadfront is made of vulcanized fibre for its insulating properties, shock protection and printability . . . the mounting panel of the clock is made of Taylor laminate XP-1-231, chosen for high strength and good punchability.

Have an Insulation Problem?

Taylor will provide the answer . . .

Select from Taylor's complete line of materials—laminates and vulcanized fibre—to get the right combination of electrical, physical and machining properties for your product. And, if you have a unique problem, Taylor will develop a special material to meet your requirements.

For example, rigid requirements for insulation materials in the Tork Clock Company's Time Switch were met by two Taylor materials—a laminate and vulcanized fibre. The mounting panel is made of Taylor laminate XP-1-231, especially formulated for the high strength and good punchability requirements of this application. In addition, Taylor vulcanized fibre serves as the deadfront—a shockproof cover removed only for installation and service. Fibre was chosen for its insulating properties, shock protection, and printability.

Taylor materials are developed to meet the need for dependable, moisture-resistant insulation. They have high dielectric and mechanical strength, and maintain original characteristics over long periods of time, under severe operating conditions. When you choose—and use—Taylor products, you'll have performance with stability.

Taylor application engineers can help you obtain the Taylor material that matches the exact requirements of your product. Contact your nearest Taylor sales office.

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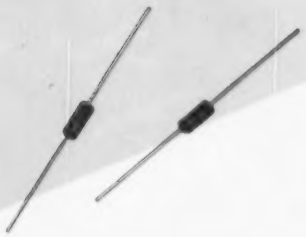
Transitron

MILITARY type silicon diodes



1N457
1N458
1N459
1N251

TRANSITRON'S Military type silicon diodes are designed to meet the requirements of MIL-E-1, and are characterized by reliability under the most severe operating conditions.

Their subminiature size and rigid specifications make them ideal for a wide range of applications. Types 1N457, 1N458, and 1N459 are intended for low and medium frequency uses, requiring voltage ratings up to 175 V. Type 1N251 is a high frequency diode especially designed for detector and high speed pulse units.

In addition to these four military types, silicon diodes meeting many other application requirements are also available. These include high conductance types, as well as fast switching-high voltage diodes.

Type	Minimum Forward Current at + 1 v (ma)	Inverse Current at Specified Voltage (μa)	Maximum Operating Inverse Voltage (volts)	MIL-E-1 TSS #
1N457	20	.025 @ −60 V	60	1026
1N458	7	.025 @ −125 V	125	1027
1N459	3	.025 @ −175 V	175	1028
1N251*	2	.2 @ −10 V	30	1023

*Inverse recovery time under .15 microseconds

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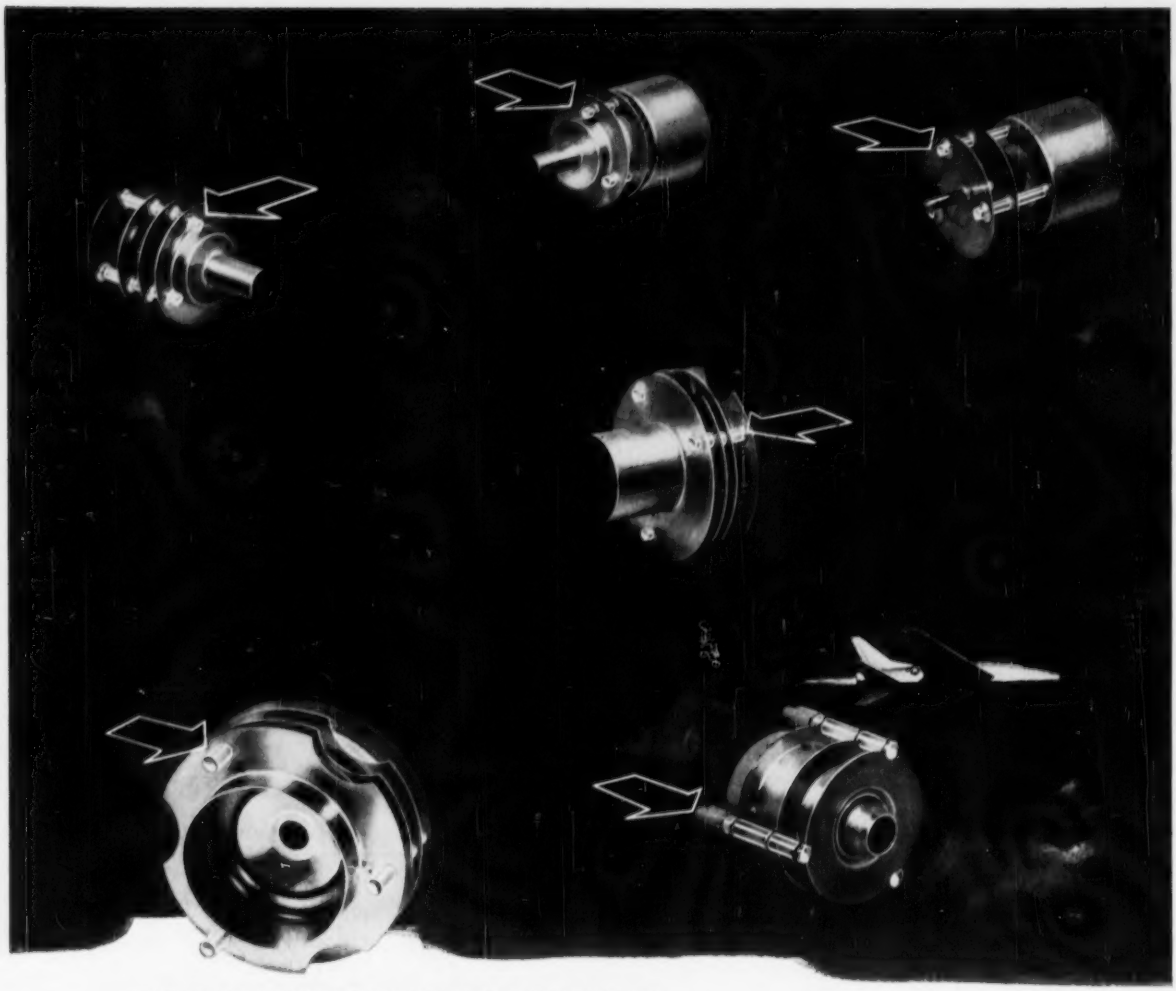

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LINDE sapphire is also available as tubes, balls, windows, and domes, and in special shapes. It has strength at high temperatures, and excellent ultra-violet and infra-red transmission characteristics. Detailed information on physical and electrical properties of LINDE sapphire is yours for the asking. Please write to "Crystal Products Dept. BD-5."

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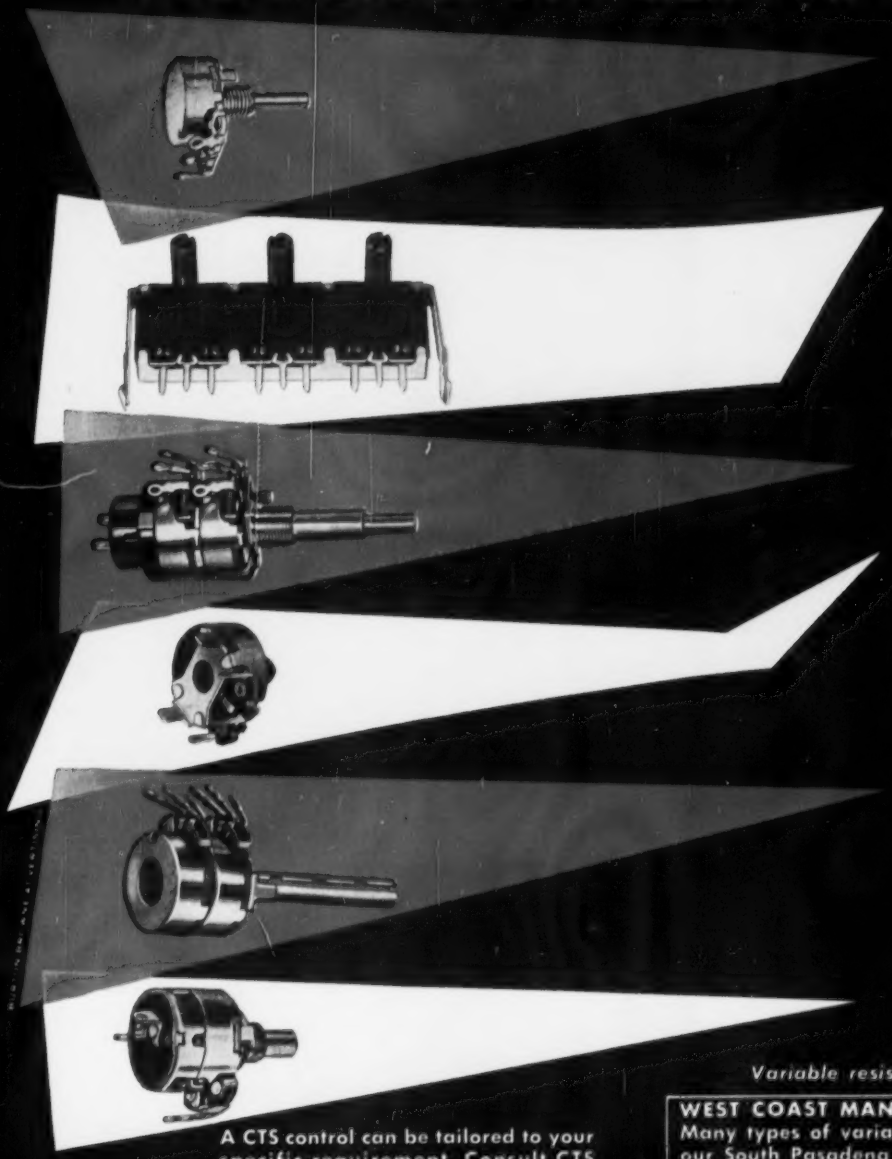

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SM SERIES

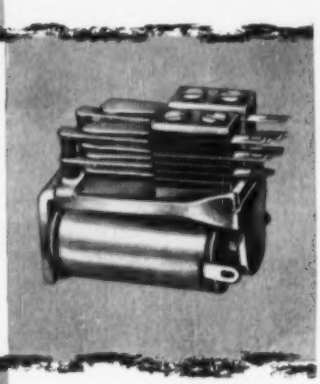
(In both voltage and current actuated models.) (Sensitivity 75 M.W. for current actuated models.) Medium cost, light weight, hermetically sealed relay for light contact load application. Size: ¾" diameter 1 13/16" high (above standard 7-pin miniature tube socket).

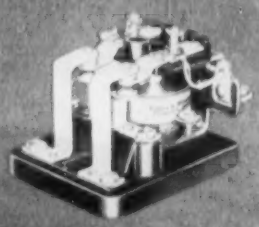
KRP SERIES

Versatile, multi-contact arrangements. Enclosed in polystyrene dust cover. Contacts: rated 5 amperes. Dimensions: 1 13/32" x 1 13/32" x 2" high (above standard 8 or 11 pin octal style socket.) Weight: 3 oz.

MH SERIES

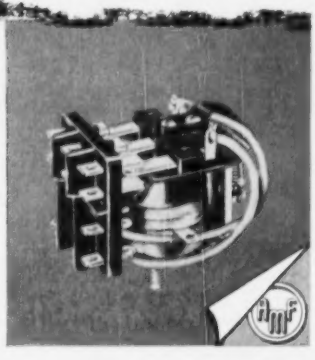
Extremely fast acting and long life. DC models available up to 10 g—500 cps vibration and 30 g shock. Available 4 form C contacts and variety of mtg. arrangements. Maximum size 1 5/8" x 3 5/32" x 1 9/16" high.





PR SERIES

Heavy duty relay with screw terminal for all industrial control applications. All AC models can carry UL label. Size: 2 1/2" wide x 3 3/8" long x 2 5/16". Mounting: Two holes 3/16" dia. on 1 7/8" centers. Contacts: Capacity, 15 amperes single break and 20 amps double break.



KA SERIES

A small, low cost, highly efficient general purpose relay with 5 amp. silver contacts. Can be insulated to meet UL requirements. Size: 1 1/4" x 1 27/32" x 1 3/4". Mounting: One No. 6/32 stud and locating tab.

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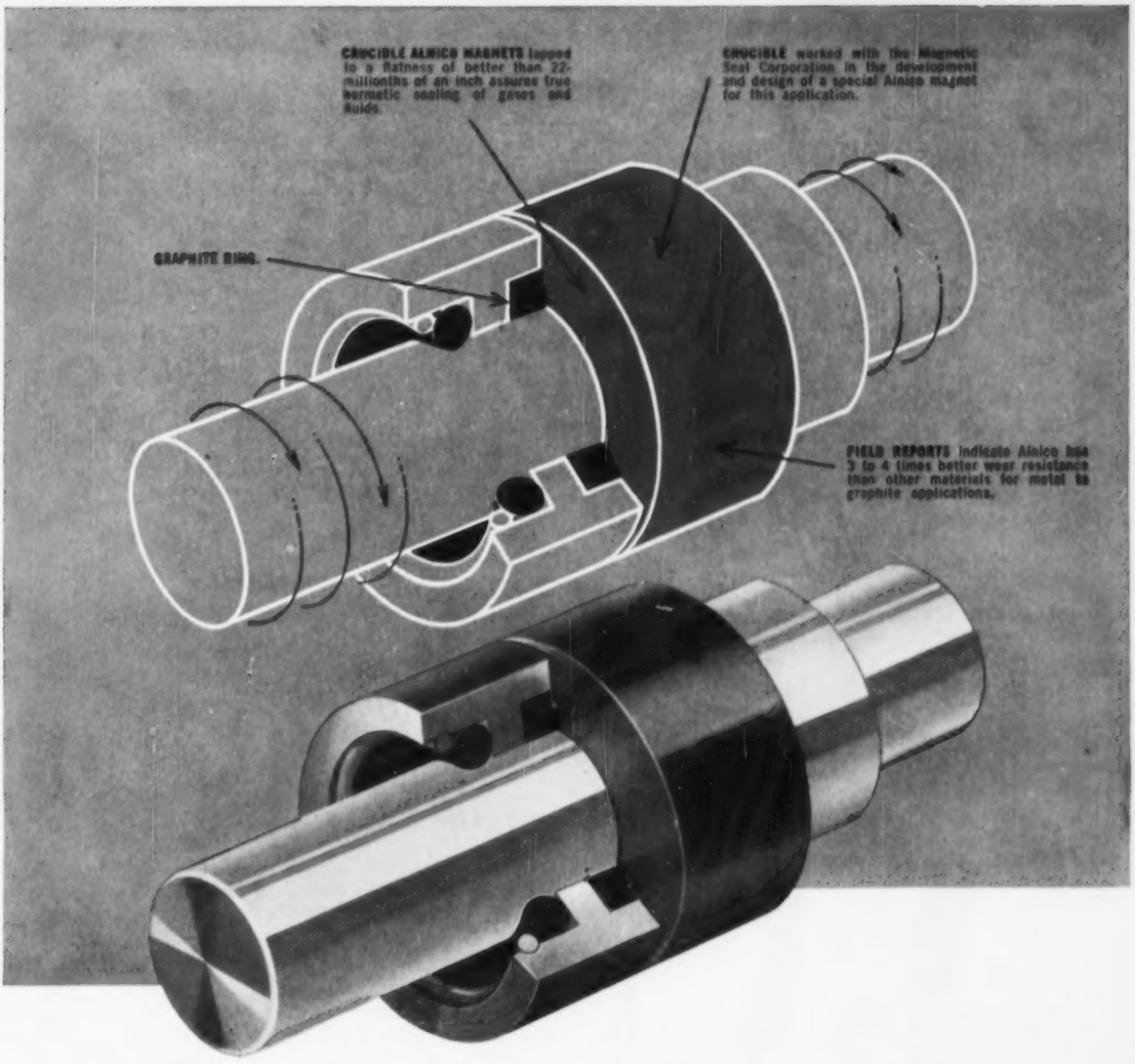
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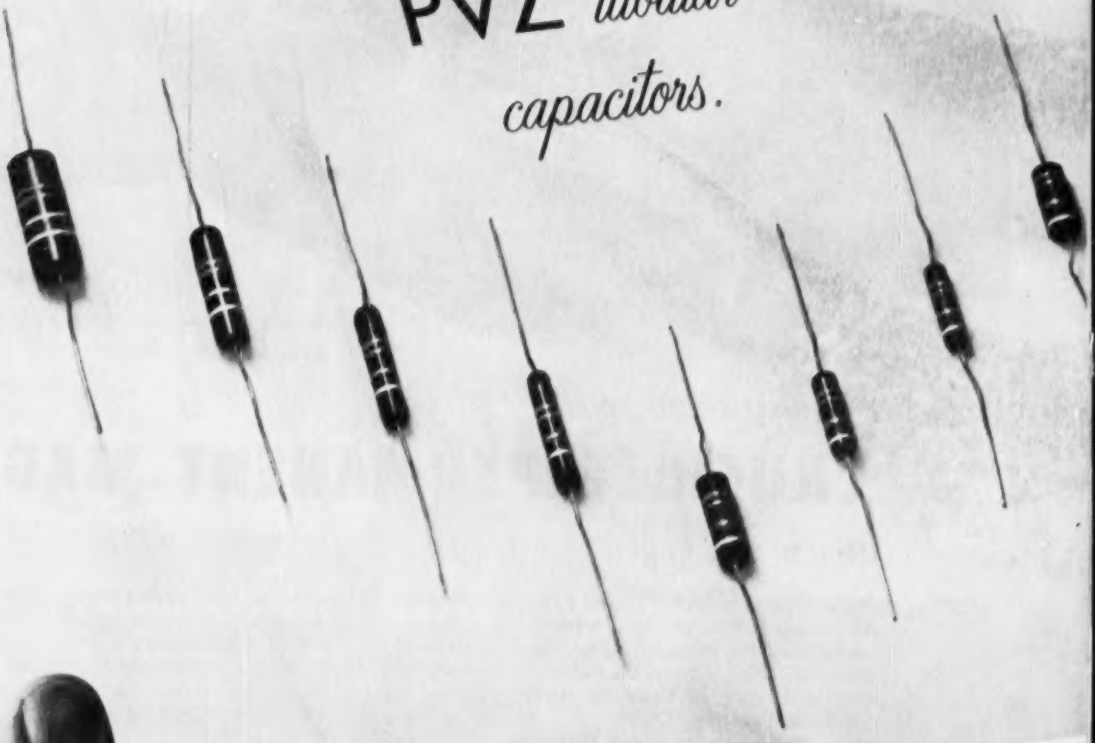
PVZ *tubular*
capacitors.



A new line:

General Electric's molded PVZ* tubular capacitors operate from −55 C to +125 C

. . . yet are moderately priced

The new General Electric molded PVZ paper tubular capacitors meet the electronic designer's need for a high-quality line that offers, at a moderate price, characteristics similar to "K" of MIL-C-25A.

- Price of the units is less than one-half that of a comparable metal-clad tubular.
- They are designed for a minimum of one year's life, operating at 125 C, rated voltage.
- Insulated bodies are easy to locate in the chassis, and provide protection from other parts or ground.
- They are small, both physically and electrically, in order to aid equipment miniaturization.
- They are solid—resistant to shock and vibration.

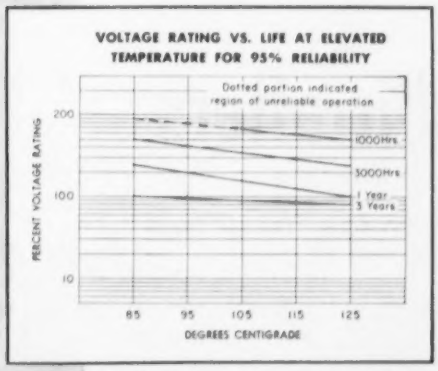
In general, you will find these molded PVZ paper tubular capacitors suitable for use where you might normally expect to find either 85 C or 125 C metal-clad tubular capacitors; in computers, missiles, telephone equipment, and other high-grade military and commercial electronic equipment.

Microfarad ratings extend *down* to .00047 uf—100 to 400 volts; *up* to .15 uf—100 volts, .1 uf—200 volts, .068 uf—300 volts, and .022 uf—400 volts. Capacitance ratings are available with ±20%, ±10%, ±5% tolerances.

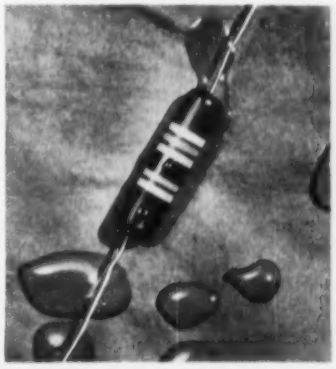
In many instances, the units are physically smaller than equivalent metal-clad tubulars, especially if the metal-clads are insulated. PVZ capacitors range in size from .175" diameter x $\frac{5}{8}$" long to .375" diameter x $1\frac{1}{16}$" long. Nine different sizes are offered to accommodate the various ratings.

READY NOW: Stocks of most sizes and ratings of General Electric's new PVZ capacitors are on hand, ready for shipment. If you would like to receive technical data on the new line get in touch with your local G-E Apparatus Sales Office or write to the General Electric Company, Section 442-43, Schenectady 5, N. Y.

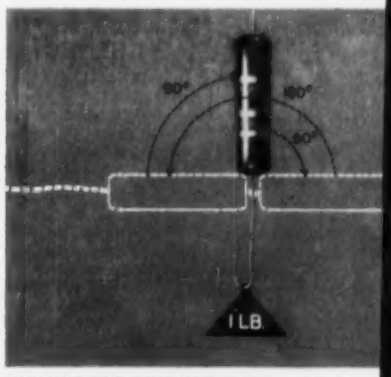
*A General Electric Trade-mark.



OPERATES FOR 1 YEAR AT 125 C Molded PVZ capacitors are designed for a minimum of one year's life at rated voltage and 125 C operation. Curves shown above are typical of performance.



EXCELLENT HUMIDITY CHARACTERISTICS Molded PVZ capacitors withstand stringent humidity tests, thanks to a combination of high-grade case material and carefully-controlled molding techniques.

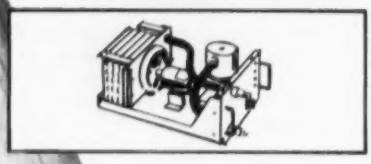


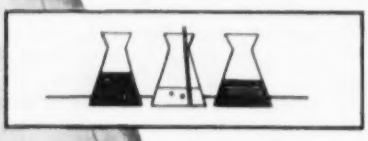
HIGH LEAD BEND RESISTANCE The new capacitors withstand one-pound-vertical-pull test moving the body of the unit 90°, then 180° in the opposite direction, then back 90°, to the original vertical position.

Progress Is Our Most Important Product

GENERAL ELECTRIC

Who put out the "fire" in the tail?





SPECIAL CONTROL DEVICES

The following special devices are standard equipment for closer control of electronic equipment operating conditions:

1. *Overheat thermostat control.* Provides emergency shut-off of entire electronic system in event of failure of any electronic device.

2. *Self-actuating temperature bypass valve.* Permits predetermination of optimum liquid temperature and control within very close limits ±2° C.

3. *Flow control valve.* Exclusive new Hallicrafters device operates independently of system pressure, supplies emergency shut off of Electronic Equipment in event of pump failure or blockage.

Hallicrafters . . . with a revolutionary, mass produced cooling unit for airborne electronics. Dissipation up to 7,000 watts . . . 20% less costly . . . 30% lighter.

Tested, proven, set for mass production – Hallicrafters new Models CR-2, CR-5 and CR-7 airborne cooling units meet environmental conditions of MIL-E-5272 specification. Revolutionary design permits use of standard racks (CR-7 dimensions: 15⅜" x 199/16" x 10⅝") and also accommodates whatever auxiliary gear, such as relays and switches, you may desire.

Vital weight factor is another advantage. For instance: the CR-5 weighs just *30* lbs., is *30% lighter* than conventional 5,000 watt units. And your choice of cooling fluids gives great flexibility of application: silicone oil; ethylene-glycol solution; hydraulic fluid.

Only Hallicrafters fits rated dissipation to *your needs.* Three stock units available – 2,000, 5,000, and 7,000 watts. Design adaptable to intermediate ratings with comparable advantages in cost, weight and performance.

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Tested and proven in many airborne installations of Hallicrafters electronic equipment.

The hallicrafters Company

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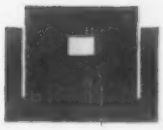
1947

CERAMAG 2

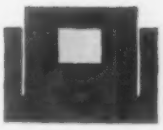
The first ferrite used commercially in TV flybacks since Stackpole pioneered this application in 1946.



1948

CERAMAG 5 and 5N

Boosted flyback voltages without increasing transformer size. Denser, higher permeability materials with greatly improved temperature characteristics.



1950

CERAMAG 7 and 7A

Permitted larger picture tubes and even higher anode voltages thanks to their higher permeability under high flux conditions.

ONE AFTER ANOTHER, succeeding Stackpole Ceramag developments have set higher and still higher quality standards for ferromagnetics.

And the search never stops . . . for new grades, new manufacturing and quality control techniques that will provide tomorrow's TV receivers with Ceramag cores that are fully as far advanced as these previous Stackpole "firsts."

1953

CERAMAG 20

This is the famous Stackpole grade that shrank TV transformer size while maintaining high performance. Hysteresis losses were about 50% of previous grades. Permeability was approximately 60% higher.

NEXT!

CERAMAG

Look to Stackpole for the latest ferromagnetic developments that will set the pace in terms of higher efficiency . . . greater electrical and mechanical uniformity.

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THE POWER BEHIND THE TV PICTURE..

...SINCE 1946

Electronic Components Division
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St. Marys, Pa.

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AEROCOM'S 1046 H.F. TRANSMITTER

POWER + STABILITY

1000 WATTS WITH .003% STABILITY

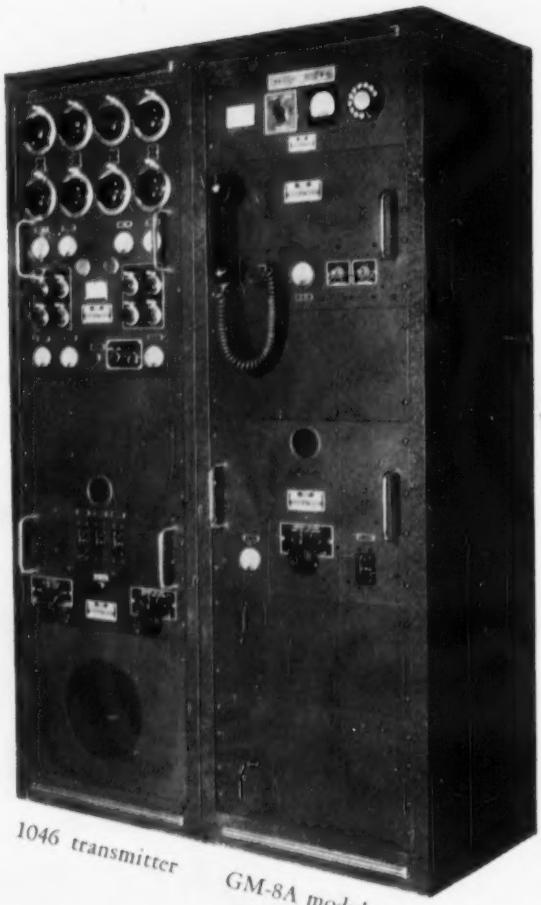
Rugged, versatile general purpose H.F. transmitter—Aerocom's 1046 packs 1000 watts of power and high .003% stability under normal operating conditions (0° to +50° C.). Excellent for point-to-point or ground-to-air communications.

Multi-channel operation on telegraph A1, or telephone A3 with GM-8A modulator... new Aerocom 1046 can be *remotely controlled* with TMC-R at control position and uses only one pair of telephone lines. In A3 operation, the local dial control panel is located in modulator cabinet.

Transmitter cabinet has 8¾ inch panel space available for either local dial control panel or frequency shift keyer.

Model 1046 operates on 4 crystal-controlled frequencies (plus 2 closely spaced frequencies) in the band 2.0—24 Mcs. Operates on one frequency at a time; channeling time 2 seconds. Operates into either balanced or unbalanced loads. Operates in ambient -35° to+50° C. Power supply: nominal 220 volts, 50-60 cycles, single phase.

Complete technical data on request



1046 transmitter GM-8A modulator

Now! Complete-package, 192 channel, H.F., 75 pound airborne communications equipment by Aer-O-Com! Write us today for details!

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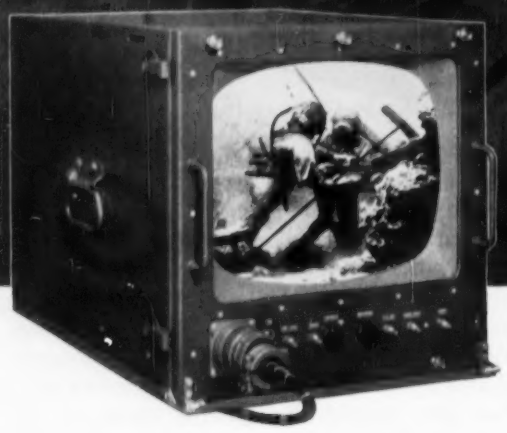
...in the air

...even under water



The image orthicon may not be pictured for reasons of security. However, the monitor on which the picture is displayed is commercially available. Designed for the Armed Forces, it is a unit of unsurpassed quality offering superb resolution, extremely good linearity and such unusual features as control of size independent of linearity and the ability to reverse the phase of the signal. Write for detailed description and price.

The human eye is a remarkably sensitive instrument. But it is no match for the image orthicon TV camera developed by Admiral for the Armed Forces. Light from an ordinary match reveals as much to this TV camera as a man with 20/20 vision sees in the light of a 150 watt bulb. Obviously, the armed services will find countless ways to use this sharp-eyed observer for reconnaissance under adverse conditions.

Admiral developed the special circuitry that gives the image orthicon its amazingly keen "eye-sight." For all its extreme sensitivity, there is no penalty in excess bulk or weight.

Admiral has also "packaged" the unit to permit its use not only for land-based and airborne reconnaissance, but *even under water*. Development of the image orthicon again demonstrates Admiral's engineering capabilities in the field of military electronics. Inquiries are invited.

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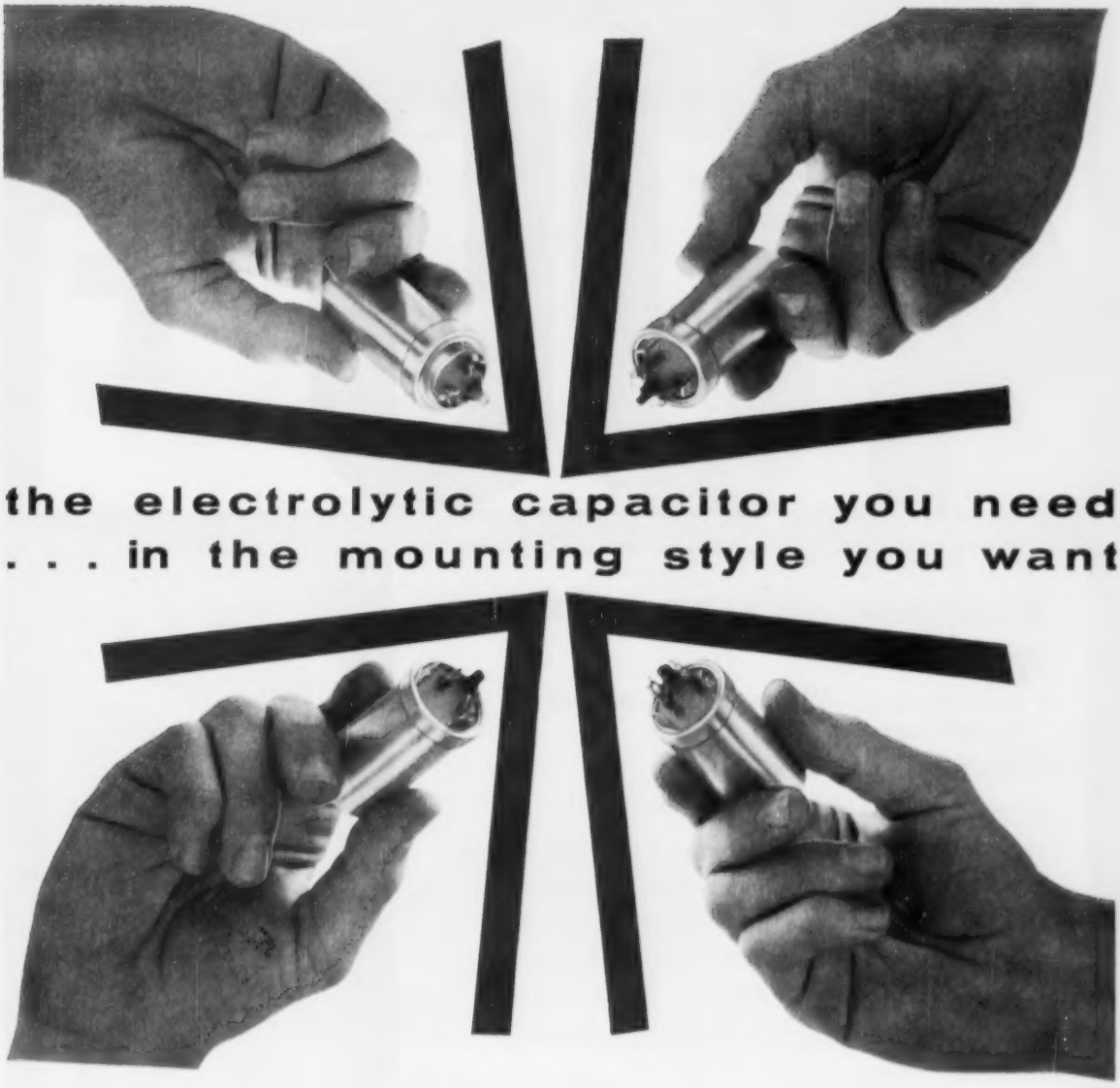

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new synchro

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Type 11-4133-01 is a size 11 torque transmitter synchro with 115V 400 cycle input. Accuracy is ±15', null voltage 175 mv, stator output 90 volts and phase shift 6.5°. Impedances are $Z_{RO}=315+J1590$, $Z_{SO}=290+J773$ and $Z_{RSS}=520+J286$.

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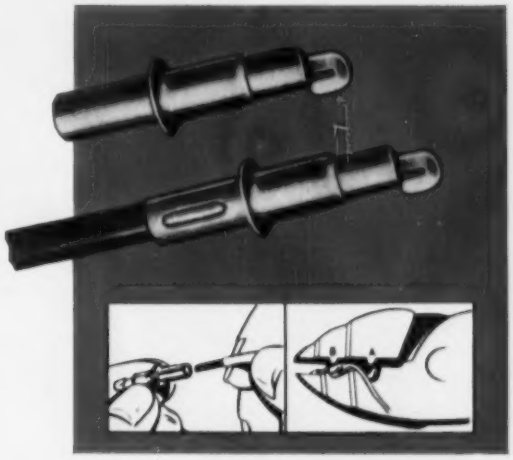
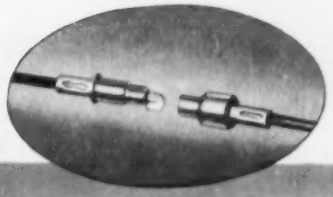
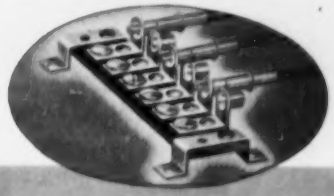


Wire to Wire

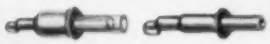


Wires to Panels

Wires to Terminal Strips



TYPE "A" PLUGS, JACKS AND EYELETS Nylon Insulated and Non-Insulated. Current Capacity: 10 amps. Wire Sizes: #14 to #18



TYPE "B" PLUGS AND JACKS Nylon Insulated and Non-Insulated. Current Capacity: 5 amps. Wire Sizes: #18 to #22

TYPE "A" ANGLE PLUGS AND DOUBLE ENDED JUMPER CORDS Current Capacity: 10 amps.

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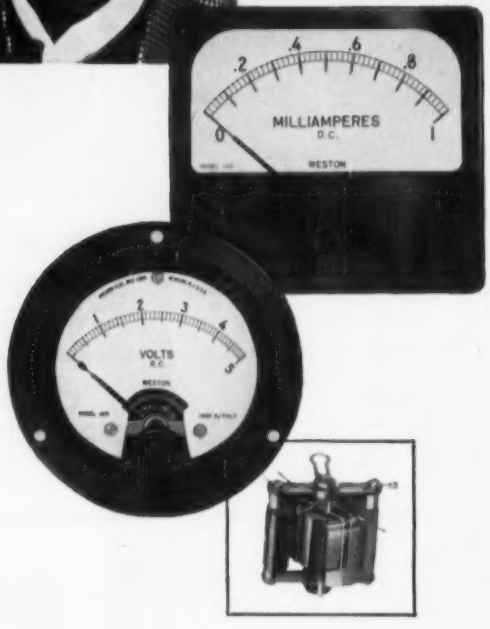

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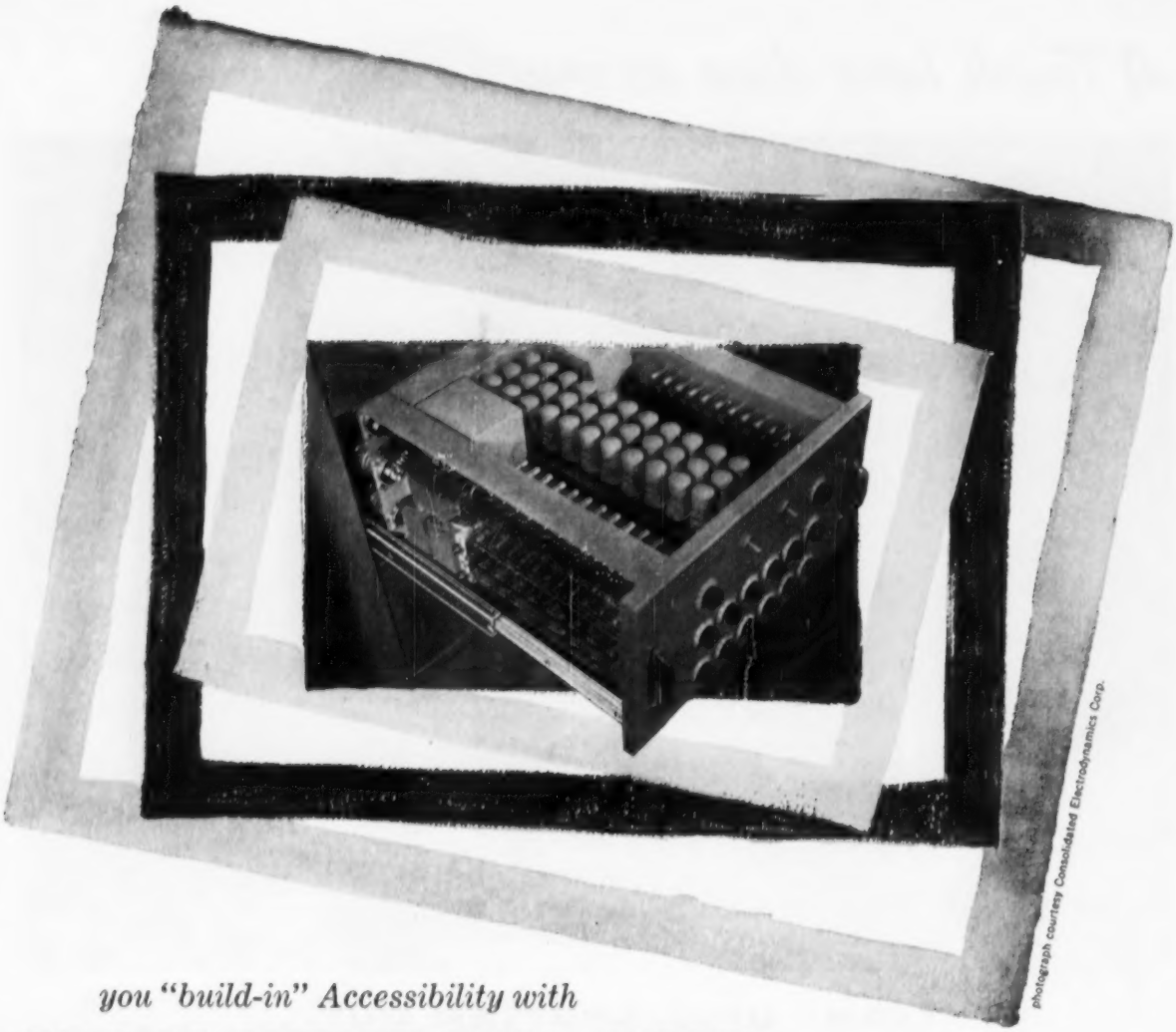

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IF it's important to keep your electronic equipment functioning with as brief interruptions as possible...**IF** even minor testing and replacement takes undue time because of the nuisance of getting at the equipment mechanically...**IF** certain components *must* be accessible for on-the-spot servicing in seconds...**THEN** you should investigate Grant Industrial Slides.

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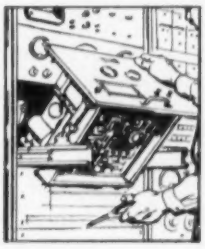

Five seconds to put chassis in testing position. Slides smoothly out of rack, locks. Pivoting mechanism brings underchassis parts to easiest working angle. Functioning of unit need not be interrupted!

Write for Grant Industrial Slide technical data. Free copy will be mailed on request.

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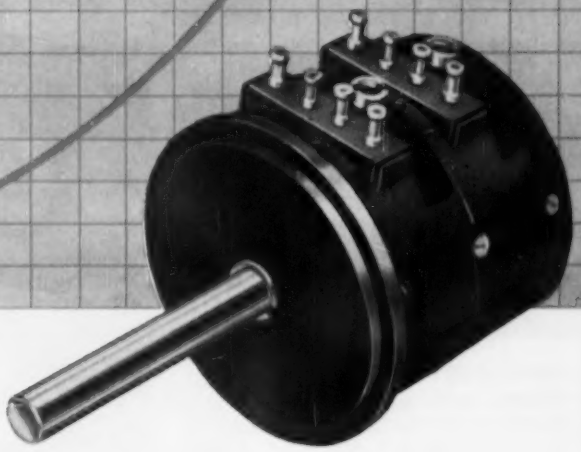

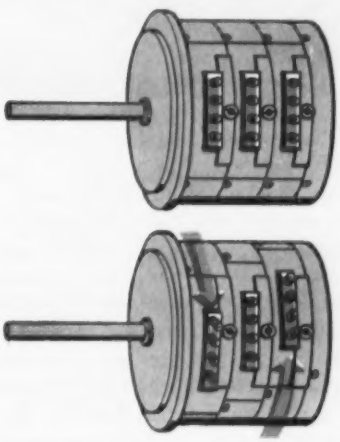

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Veeder-Root's new series of Data Readout Counters combines visual indication with electrical readout for remote indication, recording, and controlling applications. *Electrically* or *mechanically* driven and provided with *manual* or *electric* reset, these counters present a positive display of accumulated totals and automatically create specific control circuit contact closures for each number visually displayed. Each instrument, with its five figure capacity, provides 100,000 distinct circuit arrangements which lend themselves to the most exacting control and transmission requirements. The counters are compatible with standard data processing equipment and offer a wide variety of applications in the industrial control and data processing fields.

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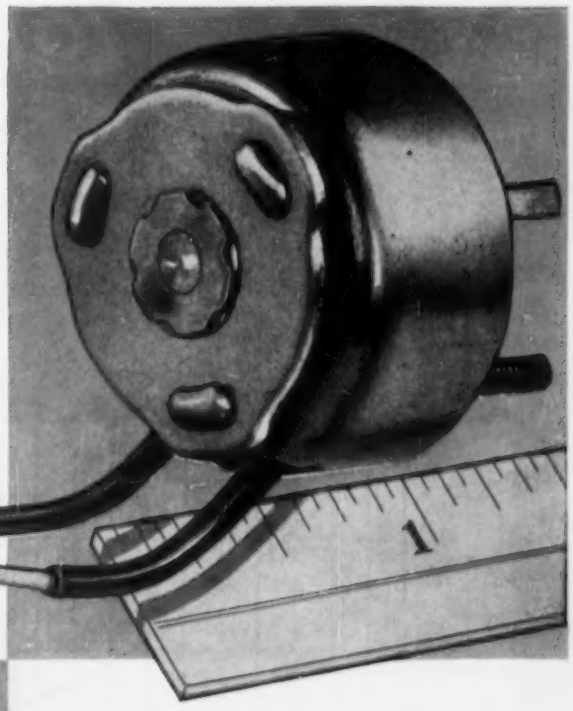
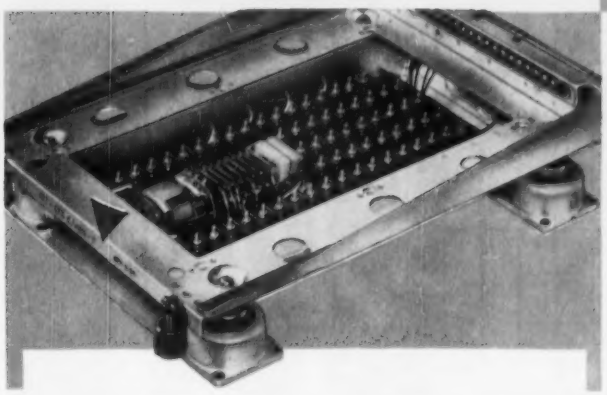
built for you separately or in remote-controlled subassemblies





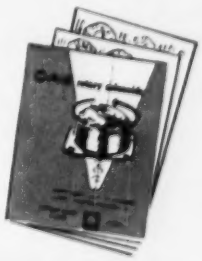
TYPICAL OAK SUBASSEMBLY WITH ROTARY SOLENOID *(MT273E BASE BUILT FOR BENDIX RADIO DIV.)*

Oak stamps, draws, welds, and etches the aluminum chassis . . . builds the rotary solenoid switch . . . manufactures the screw machine parts . . . makes the complicated cable harness . . . assembles all the parts . . . then runs life tests, heat and cold checks, and humidity chamber trials.

Oak can offer you complete engineering and manufacturing facilities for electro-mechanical subassemblies, plus a knack for making complicated devices producible. Time and again, Oak engineers have suggested changes that resulted in lower costs and better operation.

meet the most severe MIL specifications

In converting a straight pull to rotary motion, Oak rotary solenoids give a high-torque, positive action, even under severe mechanical operating conditions. Oak rotary solenoids are compact, also, and help economize in wiring and mechanical linkage on remote-control devices. Three standard sizes in many variations cover a wide range of switching and light mechanical tasks. Oak also can supply *any component* needed to accompany rotary solenoids. Because Oak engineers know the application possibilities of rotary solenoids inside and out, consult them early in the design stage. They can save you valuable time. Write for a copy of Oak's rotary solenoid bulletin that includes time-saving layout sheets.



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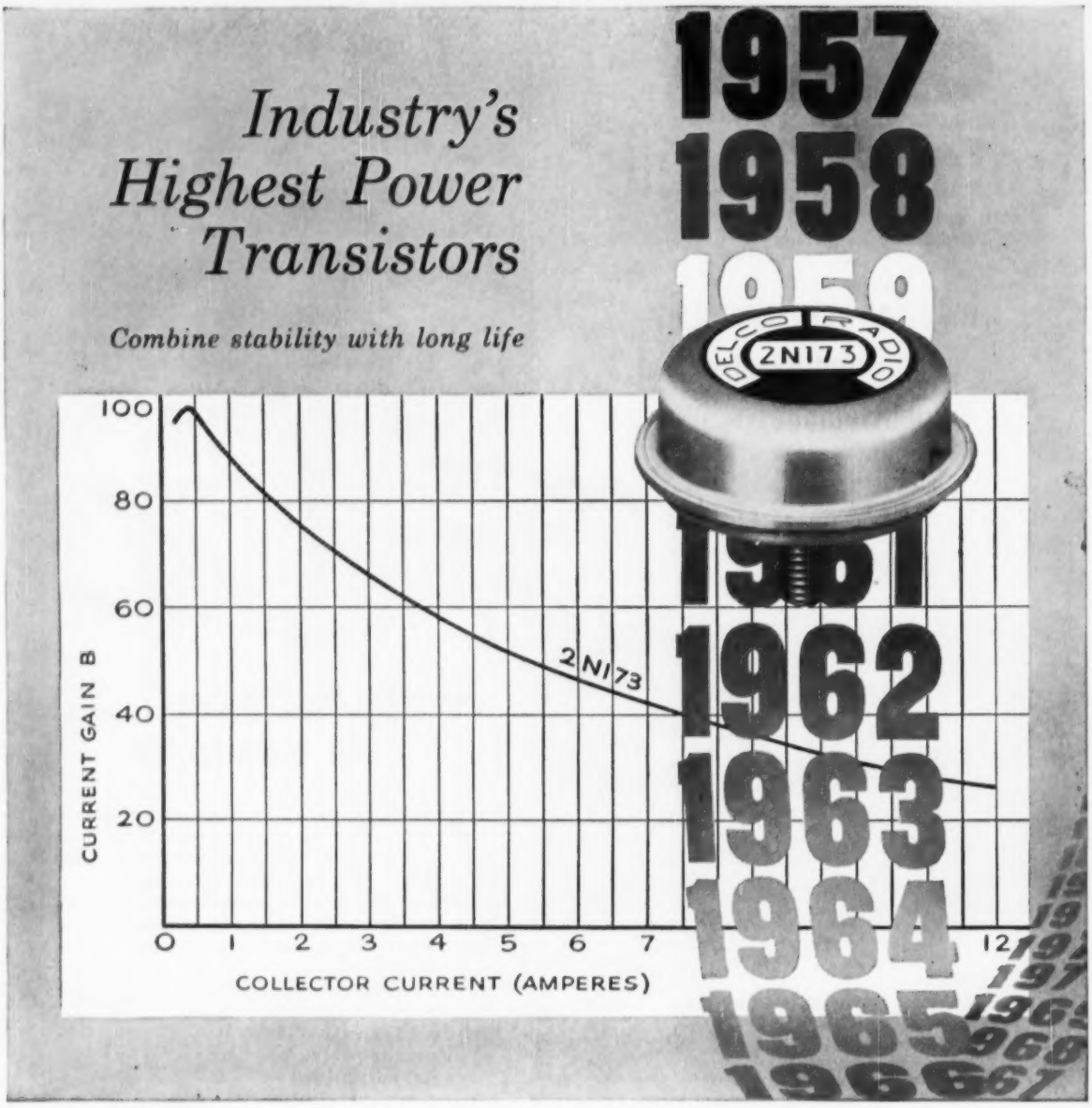

Delco Radio's 2N173 and 2N174 alloy junction germanium PNP transistors have unusual stability and reliability. These superior characteristics are retained by hermetic seal and proper internal atmosphere.

In addition, normalizing processes contribute to the high output power, high gain and low distortion characteristics that were designed into them. Delco Radio High Power transistors, ideal for your audio as well as general power applications, are produced by the thousands every day. Write for information and engineering data.

TYPICAL CHARACTERISTICS

	2N173	2N174	2N277
Properties (25°C)	12 Volts	28 Volts	12 Volts
Maximum current	12	12	12 amps
Maximum collector voltage	60	80	40 volts
Saturation voltage (12 amp.)	0.7	0.7	0.7 volts
Power gain (Class A, 10 watts)	38	38	38 db
Alpha cutoff frequency	0.4	0.4	0.4 mc
Power dissipation	55	55	55 watts
Thermal gradient from junction to mounting base	1.2°	1.2°	1.2° °C/watt
Distortion (Class A, 10 watts)	5%	5%	5%

DELCO RADIO DIVISION OF GENERAL MOTORS
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Complete encapsulation in Epoxy keeps moisture out. Lead entries are tightly sealed.

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This tough, durable coating is a glossy red color. No wax is needed to add further protection.

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Good-All Epoxy coated discs are available at no premium cost over types with conventional coating.

Condensed Table of Widely-Used Stock Types

DISC TYPES	CAPACITY RANGE	MAXIMUM DIAMETER	STANDARD TOLERANCES	APPLICATION NOTES
TRANSISTOR TYPE "H"	.00047-.001 MFD .0015 -.005 .006 -.01 .015 -.02 .022 -.05	.250" .375" .437" .500" .660"	G M V +80% −20%	FOR MAXIMUM SPACE SAVING. RATINGS UP TO 200 VDC
BY-PASS TYPE "B"	.00047-.001 MFD .0015-.002 .0022 -.0047 .005 -.02 .022	.290" .400" .570" .660" .790"	G M V +80% −20% ±20%, ±10%	MEET ALL REQUIREMENTS OF RETMA CLASS 2, Z5Z
STABLE TYPES "E" & "EE"	100- 330 MFD 331-1000 1001-1500 1501-2000 2001-3300 3301-5000	"E" "EE" .290 .400 .400 .570 .570 .660 .660 .... .790 .... .890	±20% ±10% ± 5%	Temperature Stability* in the Range From −25°C to +85°C is: Type "E" +5% to −15% Type "EE" 0% to −10% *Compared to 25°C reading

TEMPERATURE COMPENSATING TYPE "A"	MAXIMUM DIAMETER FOR CAPACITY SHOWN				
Temperature Coefficient	1/4"	5/16"	1/2"	5/8"	3/4"
NPO	2-12 MMF	13-22 MMF	28-60 MMF	61-75 MMF	76-110 MMF
N150	2-15	16-30	31-60	61-75	76-110
N220	3-15	16-30	31-75	75-100	101-140
N330	3-15	16-30	31-75	76-100	101-140
N470	3-20	21-40	41-80	80-120	121-170
N750	5-25	26-50	51-150	151-200	201-290
N1400	15-50	51-100	101-200	200-250	251-470

Write for a complete brochure. Samples for tests against your specifications will be supplied upon request.

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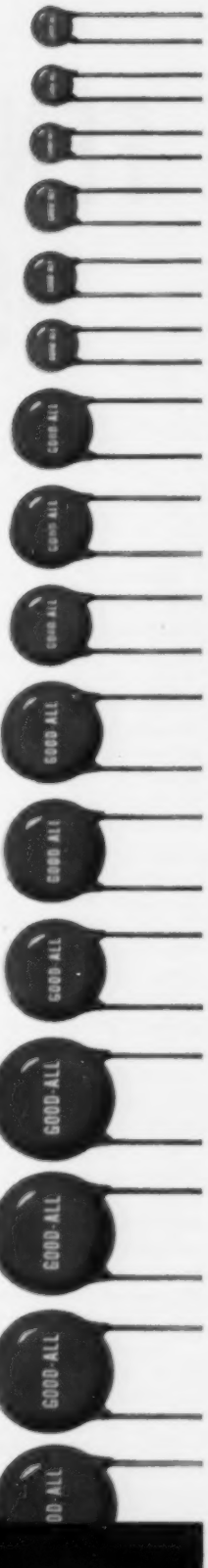

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Some Units Smaller Still

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ASHLAND, MASS. — If you want to control temperatures in tight spots, you should see Fenwal. Fenwal has cut the size of thermostats way down.

You can fit one of their Midget THERMOSWITCH units anywhere a cigarette will fit. And, if you're working with even less space, one of their Miniature THERMOSWITCH units is what you're looking for. The Miniatures are little bigger than a lump of sugar, and some are even smaller.

The Midgets and Miniatures use the same unique principle used in Fenwal's bigger THERMOSWITCH controls. They use it with the same high degree of success.

The principle of all Differential Expansion THERMOSWITCH units, large or small, is this: a single metal shell expands or contracts with temperature changes, making or breaking totally enclosed electrical contacts.

The smallness of the Midget and Miniature units does not deprive them of any of the performance characteristics that have made larger THERMOSWITCH units famous. They have THERMOSWITCH ruggedness, THERMOSWITCH accuracy, and reasonable THERMOSWITCH prices.

Temperature range of the Midget series: −50°F to 500°F. Range of the still smaller Miniature series: −20°F to 275°F.

Midgets and Miniatures, all in stainless steel, come in a variety of mountings. Hermetic sealing is also available.

These Fenwal THERMOSWITCH units are precision-engineered to give optimum temperature control with minimum-sized devices. They remain accurate under the most severe operating conditions.

You should have details on this advance in temperature control at your fingertips. Write for information to **Fenwal Incorporated, 205 Pleasant Street, Ashland, Massachusetts.**

THERMOSTATS FOR TIGHT SPOTS — A Fenwal Midget THERMOSWITCH® unit and a Fenwal Miniature THERMOSWITCH unit — two good answers to the question, "How can you install an accurate, reliable thermostat where there's almost no room?" Actual sizes of these particular models — $\frac{1}{4}$" x 2 $\frac{23}{32}$" for the Midget; 1" x $\frac{1}{2}$" for the Miniature.

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Internal and external cavity type klystrons are used in PRD microwave oscillators. Both types belong to the reflex klystron group which is usually preferred because it provides easy tuning over a relatively wide frequency range and easy frequency or amplitude modulation.

The coaxial cavity is most often used for broadband oscillators since its principal mode is the TEM. This permits greater frequency coverage than either the TE or TM modes of rectangular waveguide sections.

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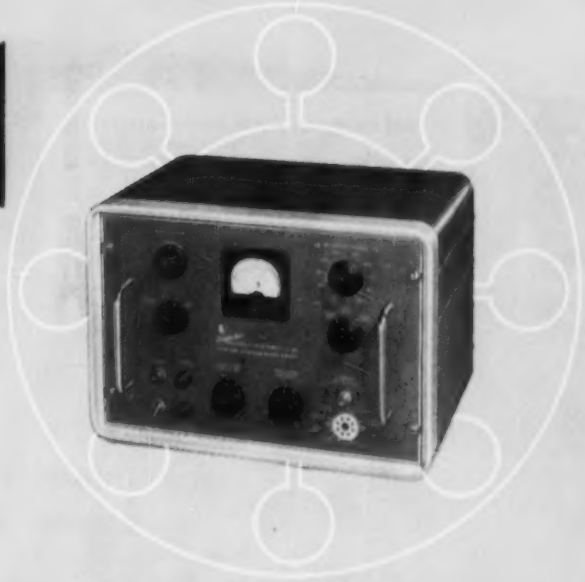
Data such as that contained in the foregoing paragraphs are available in our PRD Reports. Published periodically, these reports give practical information on virtually every aspect of microwave research and engineering. Mathematical derivations, graphs, and charts are always included. If you'd like to receive these reports (there's no charge of course), we'll be happy to add your name to our mailing list. Please address your request to: Reports Dept. R-3.



PRD Klystron Power Supply for low and medium voltage klystron tubes

Three Protective Devices Prevent Klystron Burn-out!

Another first from PRD. A compact, easily transportable klystron power supply that provides: a protective diode to safeguard the reflector against turning more positive than the cathode; a fuse in the klystron cathode return to protect the beam supply; and a "Beam Off" position to allow for warming up of the klystron filament.

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With good stability and regulation, and with square wave and saw tooth modulation plus provision for external modulation, Type 809 Klystron Power Supply is equally at home in the laboratory or on the production line.

SPECIFICATIONS

	Type	Voltage (volts)	Current (milliamperes)	Additional Specifications
Output	Beam	Continuously variable 250 to 600	0 to 65	Ripple: <5mv RMS
	Reflector	Continuously variable 0 to −900	50 μa max.	Ripple: <10mv RMS
	Filament	6.3	2 amperes	±3% center tapped

	Type	Frequency Range (cps)	Nominal Voltage (volts)	Rise Time (microseconds)	Decay Time (microseconds)	
Modulation	Square Wave	400 to 2000	0 to 90	<10	<10	Clamping circuit maintains top of square wave within 2 V of cw reflector voltage.
	Saw Tooth	60 (fixed)	0 to 125			

Price—$350 f.o.b. Brooklyn, N.Y.

For additional details on PRD 809 Klystron Power Supply, contact your local PRD Engineering Representative or write to Technical Information Group, Dept. TIG-3.

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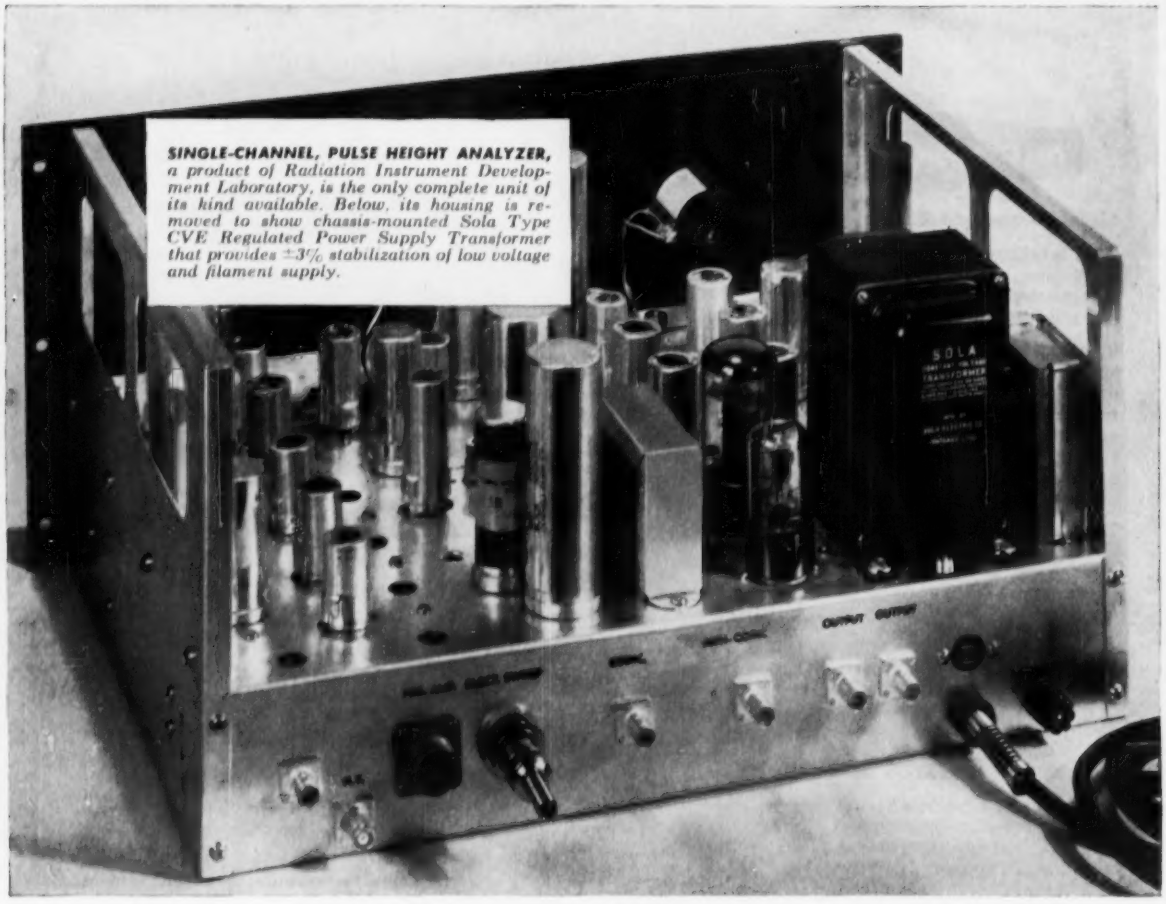

SINGLE-CHANNEL, PULSE HEIGHT ANALYZER, *a product of Radiation Instrument Development Laboratory, is the only complete unit of its kind available. Below, its housing is removed to show chassis-mounted Sola Type CVE Regulated Power Supply Transformer that provides ±3% stabilization of low voltage and filament supply.*

Sola regulated power supply transformers stabilize low voltage and filament supply for analysis of radioactive isotopes

Radiation Instrument Development Laboratory enjoys a world-wide reputation for product performance and reliability. The Sola Regulated Power Supply Transformer (Type CVE)—as a chassis-mounted component in many of RIDL's radiation instruments—is an important contributor to this exceptional reputation.

The Sola voltage stabilizer is the ideal power supply transformer for many types of electronic equipment. It provides a single, compact source of plate and filament supply voltages regulated ±3%, even though line voltage varies from 100-130 volts. It replaces conventional, non-regulating power transformers and voltage regulating circuit or components. Use of the CVE contributes not only to stable performance and extended tube life, but also to compactness and economy.

Sola Type CVE transformers are available in standard models (±3% regulation), or in special designs with regulation of one winding as close as ±1%. They have no moving parts or tubes, and regulation is completely automatic, instantaneous, and continuous.

Your area representative is listed below. He'll be happy to give you specific information on Sola Regulated Power Supply Transformers as a component in your electronic equipment.

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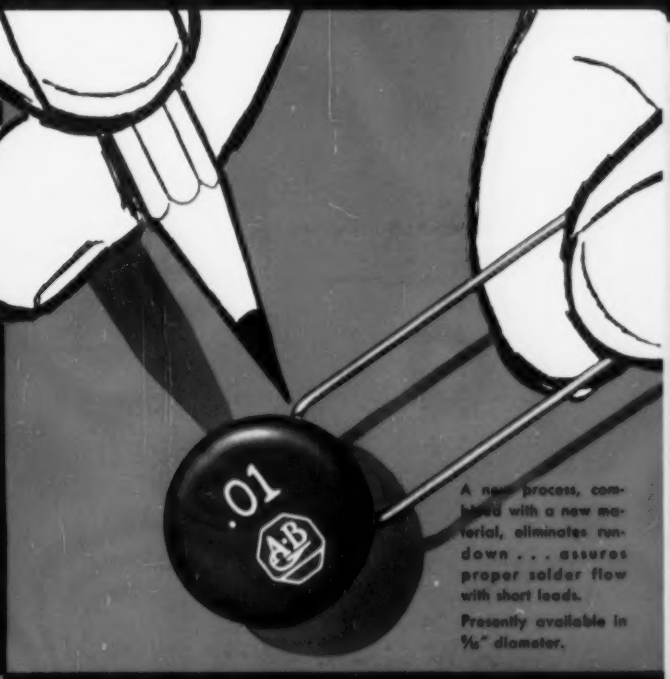
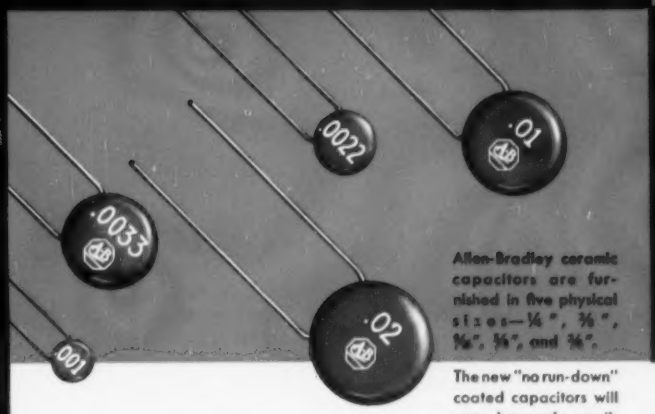
no "run-down" on the leads...



A new process, combined with a new material, eliminates run-down . . . assures proper solder flow with short leads.

Presently available in 5/32" diameter.



Allen-Bradley ceramic capacitors are furnished in five physical sizes—¼", 3/8", 5/16", 3/4", and 7/8".

The new "no run-down" coated capacitors will soon be made available in all these sizes.

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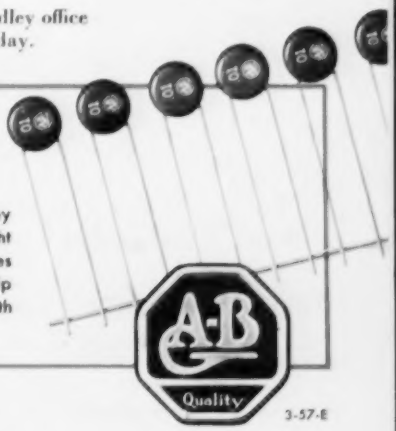

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ceramic encased
CAPACITORS

FOR CONTINUOUS OPERATION AT 150°C AMBIENT

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MEETS THE REQUIREMENTS OF MIL-C-19683 (Ships)
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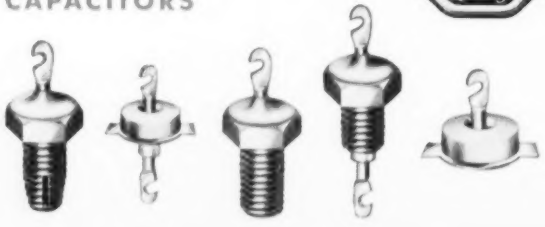

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ENGINEERING BULLETIN
ON MICRO-BEARINGS
Miniature Instrument Ball Bearings

NEW HAMPSHIRE BALL BEARINGS, INC.
PETERBOROUGH 1, NEW HAMPSHIRE

Subject: **MEASUREMENT OF RADIAL RUNOUT**

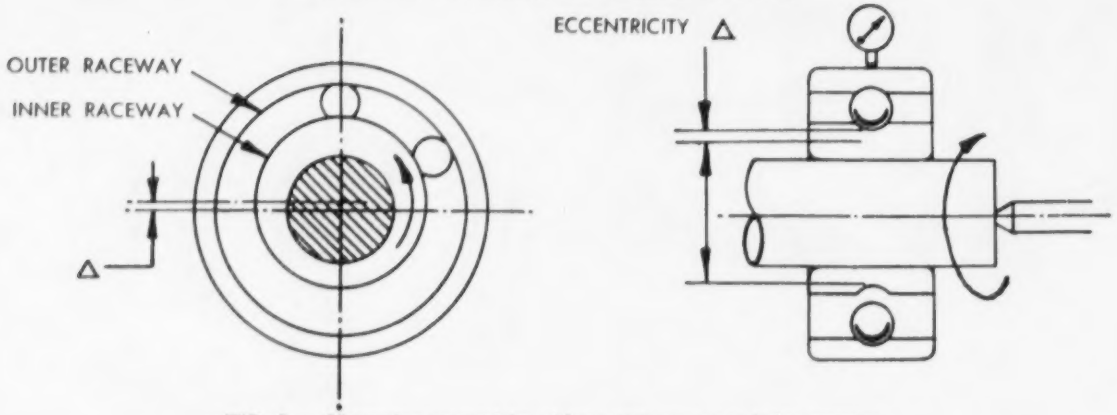

FIG. 1 — ***Measuring eccentricity of bore with respect to inner raceway.***

Occasionally questions are raised about the methods of measuring "radial runout" and "out-of-round". In order to define "radial runout" properly, a discussion of "eccentricity" and "out-of-round" is necessary.

The amount of out-of-round, or lack of roundness of a given part (inner or outer ring or ball) is the difference between the maximum and the minimum diameter of the part in question.

Eccentricity refers to the distance between the centers of two circles. Concentricity refers to the exact coincidence of the centers of two or more circles. In high grade instrument bearings there is a very small tolerance on the permissible eccentricity between the bore and the inner ring raceway, and likewise between the outside diameter and the outer ring raceway.

Inner raceway out-of-round is measured by forcing the ring between the rounded edges of two discs, one of which is fixed and the other of which is mounted on the indicating mechanism. The difference between the maximum and minimum readings reveals the amount of out-of-round. Out-of-round of the outer ring raceway is measured by placing the ring over two rounded points which engage the raceway. One point is fixed and the other actuates an indicating mechanism. As the ring is rotated, the difference between the maximum and minimum readings indicates the degree of out-of-round.

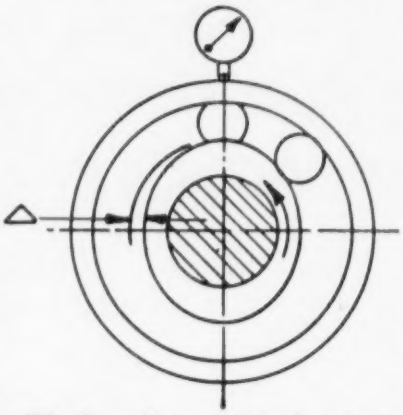

FIG. 2 — ***Inner raceway is out-of-round, although concentric with bore.***

The true amount of eccentricity between the bore and the inner ring raceway can be measured, providing these circles are not out-of-round, by mounting the assembled bearing on a slightly tapered arbor, applying a calibrated indicator on the center of the stationary outer ring, and then slowly rotating the arbor. The eccentricity is the difference between the minimum and maximum gage reading as the arbor is rotated through one revolution. Similarly, the eccentricity of the outer ring is measured by the difference in the dial readings with the arbor and inner ring held stationary while the outer ring is rotated one revolution. *Fig. 1* shows the set-up with an inner raceway which is eccentric with respect to the bore.

In the case above it has been stipulated that the bore and inner raceway must not be out-of-round, for only under these conditions is the true eccentricity measured.

If the raceway is out-of-round, while being either eccentric or concentric with respect to the bore, the out-of-round will be transmitted to the indicator, thereby influencing the reading. A condition in which the inner raceway is out-of-round although concentric is shown in *Fig. 2*.

In view of the fact that the majority of bearing rings will unavoidably be somewhat out-of-round and eccentric, however slightly, it is obvious that the measurement described above indicates neither true eccentricity nor true out-of-round but a summation of the two quantities. Hence the measurement is more correctly termed *radial runout*.

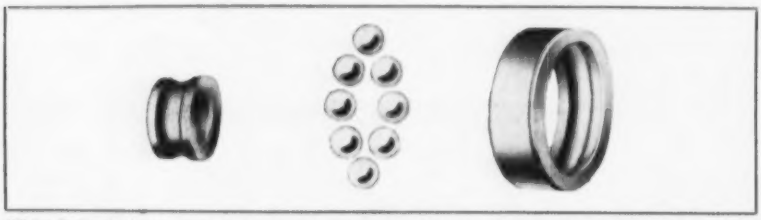

FIG. 3 ***Radial Runout is the result of eccentricity in the bearing parts. Principal factors producing it are eccentricity between bore and raceway of inner ring (left) and between raceway and outer diameter of outer ring (right). Out-of-round balls offer negligible effect, since effect tends to cancel out as balls roll.***

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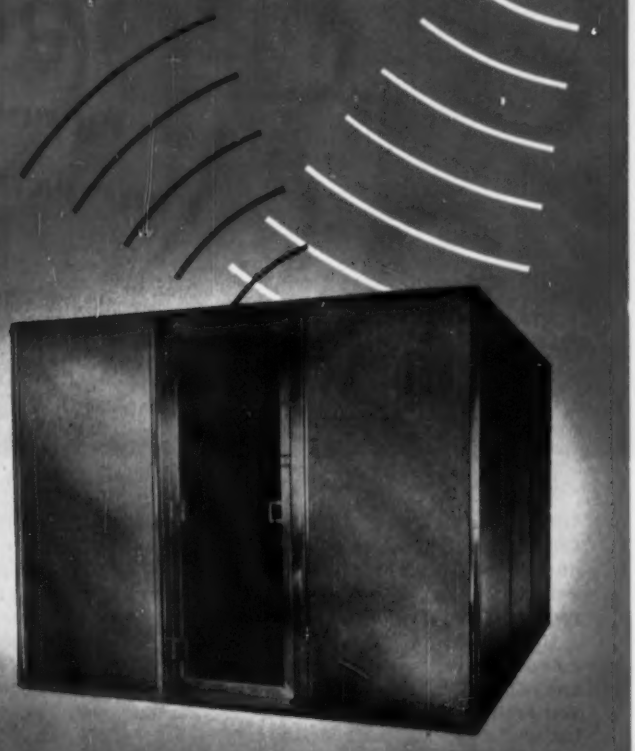

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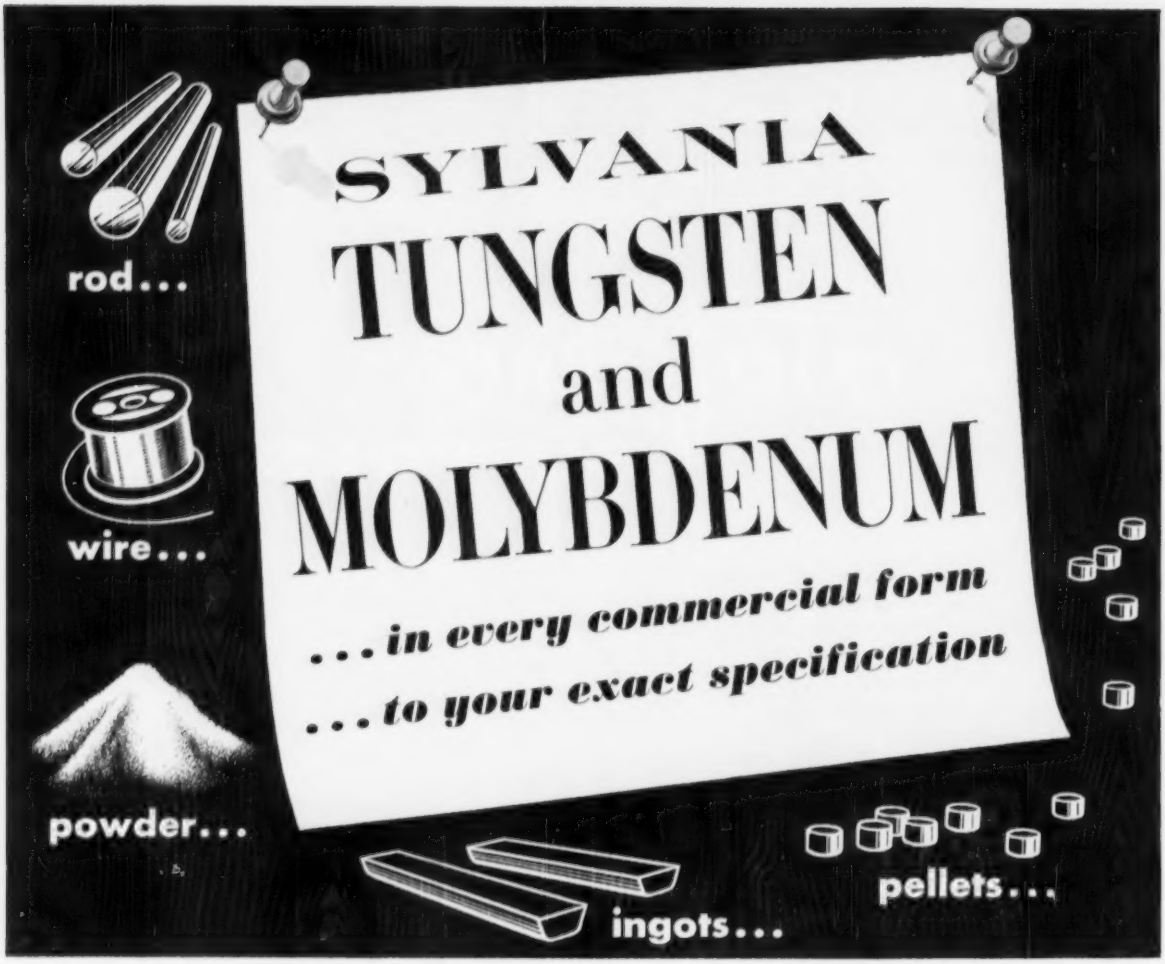

When you make Sylvania your headquarters for tungsten and molybdenum, you gain in several very important ways: Sylvania can supply metals to your *exact* specification because every step of the process is performed in Sylvania's own plants.

By maintaining complete control over every manufacturing step, the process can be altered at any point along the way to secure the characteristics you require. In addition, Sylvania can assure you the uniformity of specification required for modern automated equipment. For example, the continued improvement in tensile strength, elongation, and length of molybdenum wire has permitted more efficient operation of automatic grid winding equipment. To obtain these improvements, modifications have been not only to actual wire drawing operations but, also, to practically every step as far back as the production of metal powder.

As another example, a special tungsten rod had to be developed that could be cut and punched into ventilated contact disks without shattering. Here, each manufacturing step affected the end properties of the rod and even modifications through each chemical processing step had to be made to produce exactly the type of rod required. Obviously, complete integration was necessary.

Your Sylvania sales engineer will be glad to discuss your tungsten and molybdenum requirements. For technical data and specifications write to:

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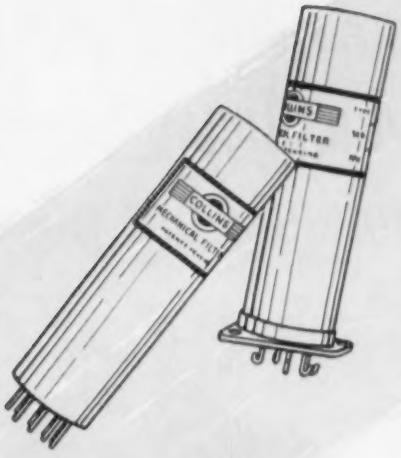

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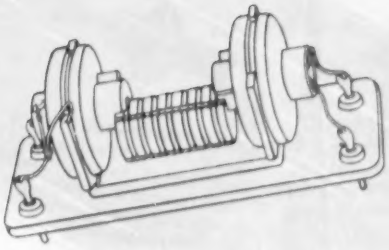

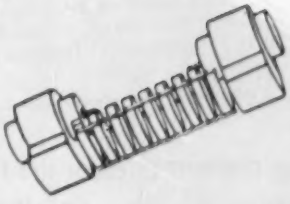

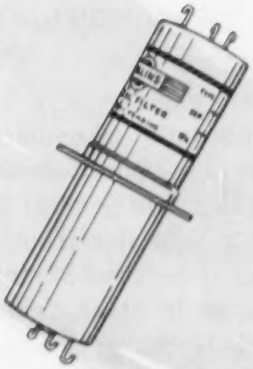

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AXIAL LEAD MODELS. The most adaptable type of Silicon Rectifier. Small, lightweight, taking ambients up to 165°C, they work anywhere, in any position. Their versatile lead mounting facilitates their use in all kinds of installations.
STACK MODELS. Assembled from Axial Lead cells mounted in fins, Stacks work singly or in groups to supply almost any power output. Each Stack is mounted with just two screws.
STUD-MOUNTED MODELS. Screw into the chassis, using it for heat removal to permit safe performance at higher currents and temperatures. Basically, the same design as Axial Lead models.

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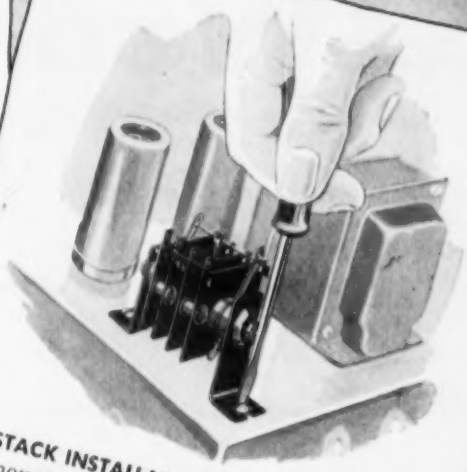
Every engineer who works with d-c power supplies for assemblies or components of moderate current demand finds a valuable source in the General Electric rectifier line. G-E Silicon Rectifiers—whether the Axial Lead or the Stud Mounting models in single cells, or in Stack assemblies with their remarkable range of current and voltage ratings – are part of our extensive range of rectifier or other semiconductor devices.

The table on output and performance figures only suggests the range of specifications available. For further data, or exact information on rectifiers for your specific needs, call your General Electric Semiconductor representative. Or write *General Electric Company, Semiconductor Products, Section S2557, Electronics Park, Syracuse, N. Y.*

STUD RECTIFIERS. Fit them in wherever you need maximum current and temperature in minimum space with rigid chassis mounting.



STACK INSTALLATION. A typical way of mounting General Electric Silicon Rectifier Stacks. Just two screws fasten the entire assembly in place.

REPRESENTATIVE G-E SILICON RECTIFIER RATINGS

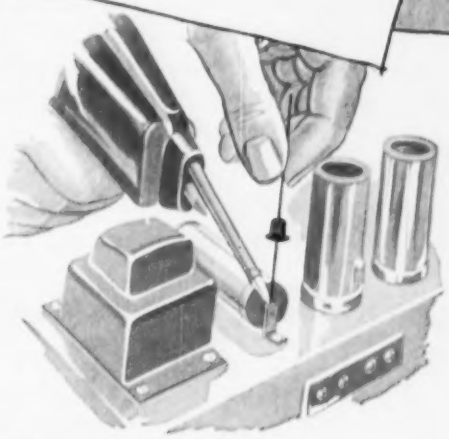
PIV	STUD*	LEAD**	STACKS***
50		1N536	4JA411F Series
100	1N1115	1N537	4JA411A Series
200	1N1116	1N538	4JA411B Series
300	1N1117	1N539	4JA411C Series
400	1N1118	1N540	4JA411D Series
NEW . . . Following is now in production			
500		1N1095	

***Maximum Current**— 600 ma @ 150°C Case Temperature
1500 ma @ 85°C Case Temperature

****Maximum Current**— 250 ma @ 150°C Ambient Temperature
750 ma @ 50°C Ambient Temperature

*****Maximum Current**— ½ amp per fin @ 150°C Ambient Temp.
1½ amp per fin @ 85°C Ambient Temp.

†For higher currents, G-E High Current Rectifiers may be used, or Stacks may be used in parallel.



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- 5 KVA to 26 KVA Ratings
- Lowered Costs
- UL Approved
- Optional Ball Bearings and Motor Drives

Type **W50H** **Variac** 230-Volt Input, 7.5 KVA, 32.5 Amp. Max. Current.

Type W50 similar except for number of terminals and dial. 115-Volt Input, 5.75 KVA, 50 Amp. Max. Current.

Type 50H VARIACS are equipped with 7 combination screw-solder terminals. Can be used on either 230- or 115-volt lines. Type W50's have 5 terminals. Note engraved wiring diagram on terminal board, showing voltage between terminals.

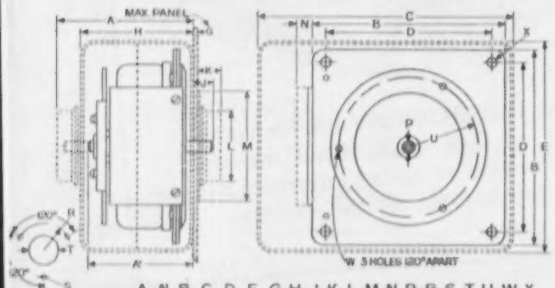
The newly designed Types W50 and W50H VARIAC Series replaces the popular Types 50A and 50B with many electrical and mechanical improvements.

Current ratings for the new 115-volt and 230-volt models are 50 and 25 amperes, against 40 and 20 for the older types. A built-in protector prevents damage from *sustained* overloads exceeding 160% of rating. This extra safety feature is available when the normal load fusing or breaker is inoperative.

The basic design of the new Type W50 Variacs is along the lines of the other new "W" models in the smaller sizes. Mounting holes and layouts are the same as the old Type 50 for ready interchangeability.

Essential Dimensions — TYPE W50 VARIACS — Specifications

50 Amperes 115-Volt Models



	A	A'	B	C	D	E	G	H	J	K	L	M	N	P	R	S	T	U	W	X
W50 W50H	–	6½	12½	–	10½	–	–	–	13	⅛	4¼	7	1	⅜	⅜	3½	¼	4½	⅜	¼
W50M W50HM	8½	–	12½	16½	10½	15⅛	⅜	7½	13	⅛	4¼	7	1	⅜	⅜	3½	¼	–	–	¼

32.5 Amperes 230-Volt Models

	W50 Uncased	W50M Cased	W50H Uncased	W50HM Cased
Input Voltage	**115**	**115**	**230***	**230***
Load Rating (kva)	**5.75**	**5.2**	**7.5**	**7.1**
Output Voltage	0-135	0-135	0-270	0-270
Rated Current (amp)	50	40	25	20
Maximum Current (amp)	50	45	32.5	31
No Load Loss at 60 c. (w)	50	50	50	50
Dial Calibrations**	0-115 0-135	0-115 0-135	0-230 0-270	0-230 0-270
Angle of Rotation (deg.)	320	320	320	320
No. Turns on Winding	190	190	298	298
D-C Resistance of Winding (Ω)	.075	.075	.3	.3
Driving Torque (oz.-in.)	200-400	200-400	200-400	200-400
Replacement Brushes	$5.00 per set	$5.00 per set	$5.00 per set	$5.00 per set
Net Weight (lbs.)	50	57	53	60
Code Word	GATAL	GATER	NITAL	NITER
PRICE	**$120**	**$145**	**$120**	**$145**
Ball Bearing Surcharge	$15	$15	$15	$15

*All 230-Volt models can be used on 115 volt lines with rated current limited to one half of the 230-volt current
**Dual plates are reversible, overvoltage connection calibrations on one side, line voltage on other

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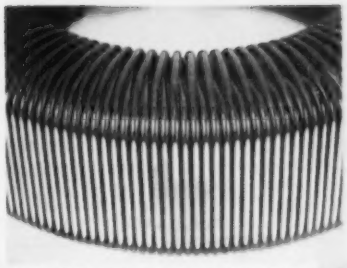
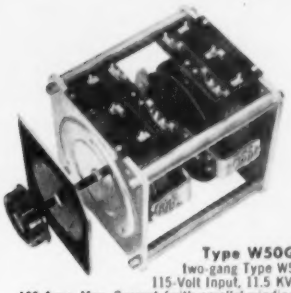


Banked winding is of #7 or #11 AWG wire! Duratrak brush track (for the first time in these high-power VARIACS) is on face of toroidal winding.

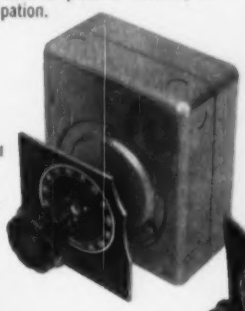
Six brushes in multiple, pigtail-equipped brush holders, readily removed for servicing or replacement — copper radiator nose and brush holder conducts current and heat to painted radiator, for maximum heat dissipation.

Wall-mounted Type W50M. Four 1 ¾" conduit knockouts provided for convenience in wiring. Four bolts through corners of base and case attach W50's to wall or panel – 2 screws in top hold cover firmly in place — captive radiator permits shaft to be extended either way for panel or wall mounting without upsetting radiator and brush settings. Note accessibility of terminal board for easy wiring.



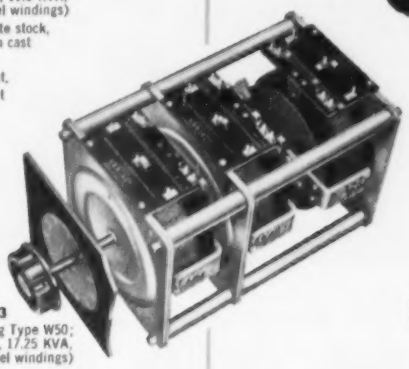
Type W50G2
two-gang Type W50;
115-Volt Input, 11.5 KVA,
100 Amp. Max. Current (with parallel windings)
Note 2-piece base stamped from plate stock, in all W-type VARIACS stronger than cast or die-cast construction

W50HG2 similar; 230-Volt Input, 15 KVA, 65 Amp. Maximum Current



Type W50M
Completely enclosed Type W50 — 115-Volt Input

W50HM similar; for 230-Volt Input



Type W50G3
3-gang Type W50;
115-Volt Input, 17.25 KVA,
150 Amp. Max. Current (with parallel windings)

W50HG3 similar; 230-Volt Input, 22.5 KVA, 97.5 Amp. Max. Current

Type W50G2M
Completely enclosed 2-gang Type W50 for 115-Volt Input.

W50HG2M similar; for 230-Volt Input

Type W50G3M
Completely enclosed 3-gang Type W50 for 115-Volt Input

W50HG3M similar; 230-Volt Input

TYPE W50

Typical Ganged Variac® Assemblies

Single Phase

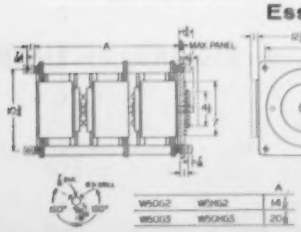
INPUT Volts	OUTPUT Kva	Volts	Amperes Max.	Amperes Rated	Type	Price	Description	Cablegram Code Word	Net Weight Lbs.
115	10.4	0-135	90	80	W50G2M	$210	2 gang — windings in parallel — requires 50-P1 Choke: $14	GATALBORDU	115½
115	11.5	0-135	100	100	W50G2	260	See above	GATALGANDU	103
115	18.5	0-135	135	120	W50G3M	440	3 gang — windings in parallel — requires 50-P1 and 50-P2 Chokes: $14 each	GATALBORTY	173½
115	17.25	0-135	150	150	W50G3	385	See above	GATALGANTY	158
230	14.3	0-270	62	40	W50HG2M	310	2 gang — windings in parallel — requires 50-P1 Choke: $14	HITALBORDU	121½
230	15	0-270	65	50	W50HG2	360	See above	HITALGANDU	109
230	21.4	0-270	93	60	W50HG3M	440	3 gang — windings in parallel — requires 50-P1 and 50-P2 Chokes: $14 each	HITALBORTY	182½
230	22.5	0-270	97.5	75	W50HG3	385	See above	HITALGANTY	167

Three Phase

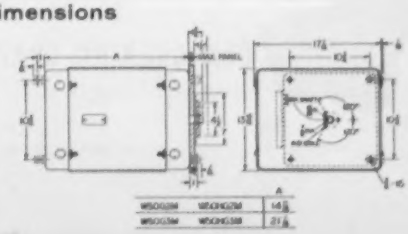
230	12.8	0-270	31	20	W50HG2M	310	Open delta circuit	HITALBORDU	121½
230	13	0-270	32.5	25	W50HG2	360	Open delta circuit	HITALGANDU	109
230	18	0-230	45	40	W50G3M	440	Wye circuit	GATALBORTY	173½
230	20	0-230	50	50	W50G3	385	Wye circuit	GATALGANTY	158
460	24.8	0-460	31	20	W50HG3M	440	Wye circuit	HITALBORTY	182½
460	26	0-460	32.5	25	W50HG3	385	Wye circuit	HITALGANTY	167

Ball Bearing Surcharges: 2-gang units — $20.00; 3-gang units — $25.00
Driving Torques (oz.-in.): 2-gang units — 400-800; 3-gang units — 600-1200
Dial Calibrations, one side only — 0-10

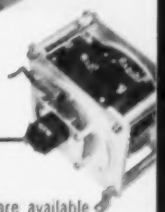
Essential Dimensions



		A
W50G2	W50HG2	14½
W50G3	W50HG3	20½



		A
W50G2M	W50HG2M	14½
W50G3M	W50HG3M	21½



Motor Drives are available for all Type W50 Variacs. ALL motor-driven units include motor capacitor, adjustable-position microswitches to limit the arc of traverse to any desired position, and ball bearings.

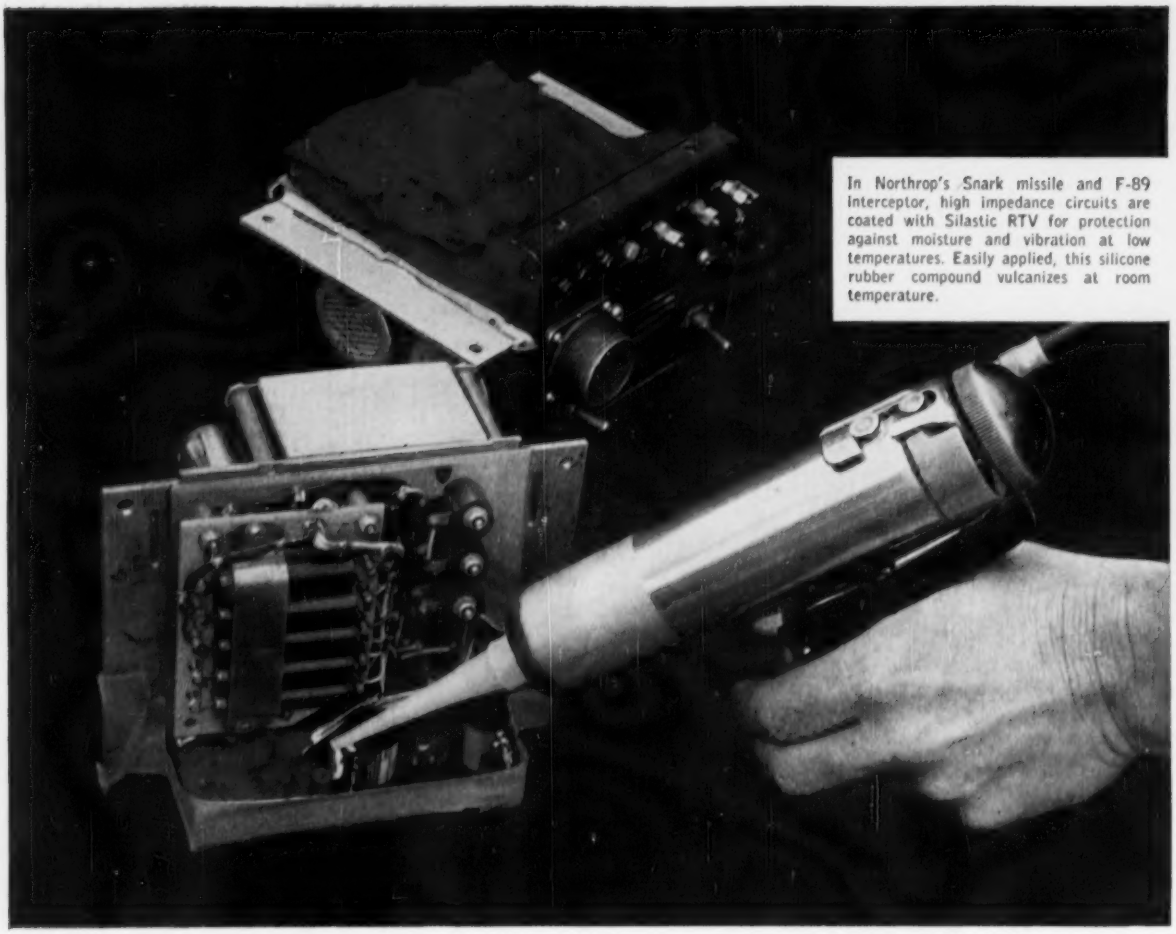
ADDITIONAL prices for equipping any Type W50 VARIAC with motor drive (including the necessary ball bearings) are:

All single units — $140.00
All two-gang units — $130.00
All three-gang units — $135.00

For motor drives, a set-up charge of $12.00 is prorated for quantity from 1 to 4. No set-up charge is made for quantities of 5 or more.

Traverse times available, in seconds, are 16, 32, 64 or 128 for single units: 32, 64 or 128 seconds for 2- and 3-gang units.

For type number terminology when ordering see page 5 of the current VARIAC BULLETIN "O". It is not necessary to add "BB" to the type number as all motor-driven VARIACS are equipped with ball bearings.



In Northrop's Snark missile and F-89 Interceptor, high impedance circuits are coated with Silastic RTV for protection against moisture and vibration at low temperatures. Easily applied, this silicone rubber compound vulcanizes at room temperature.

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RTV seals, cushions delicate circuits

Sensitive electronic components can be both cushioned and sealed against moisture by encapsulating with Silastic RTV*, Dow Corning's silicone rubber that vulcanizes at room temperature. A single coating provides protection, and in addition improves electrical properties of the unit, especially surface resistivity. Silastic RTV cures in 24 hours, and remains resilient from —100 F to 350 F. Write for complete data.

Typical Properties of Silastic for Encapsulating and Potting

• Temperature range, °F	—100 to 350 F
• Dielectric strength, volts/mil	300 to 500
• Surface resistivity at 50% relative humidity, ohms	2.8×10^{15}
• Dielectric constant, 10^2 cycles per second	2.95 to 3.05
• Dissipation factor, 10^2 cycles per second	0.01
• Moisture absorption after 7 days at room temperature, %	+3 to +5

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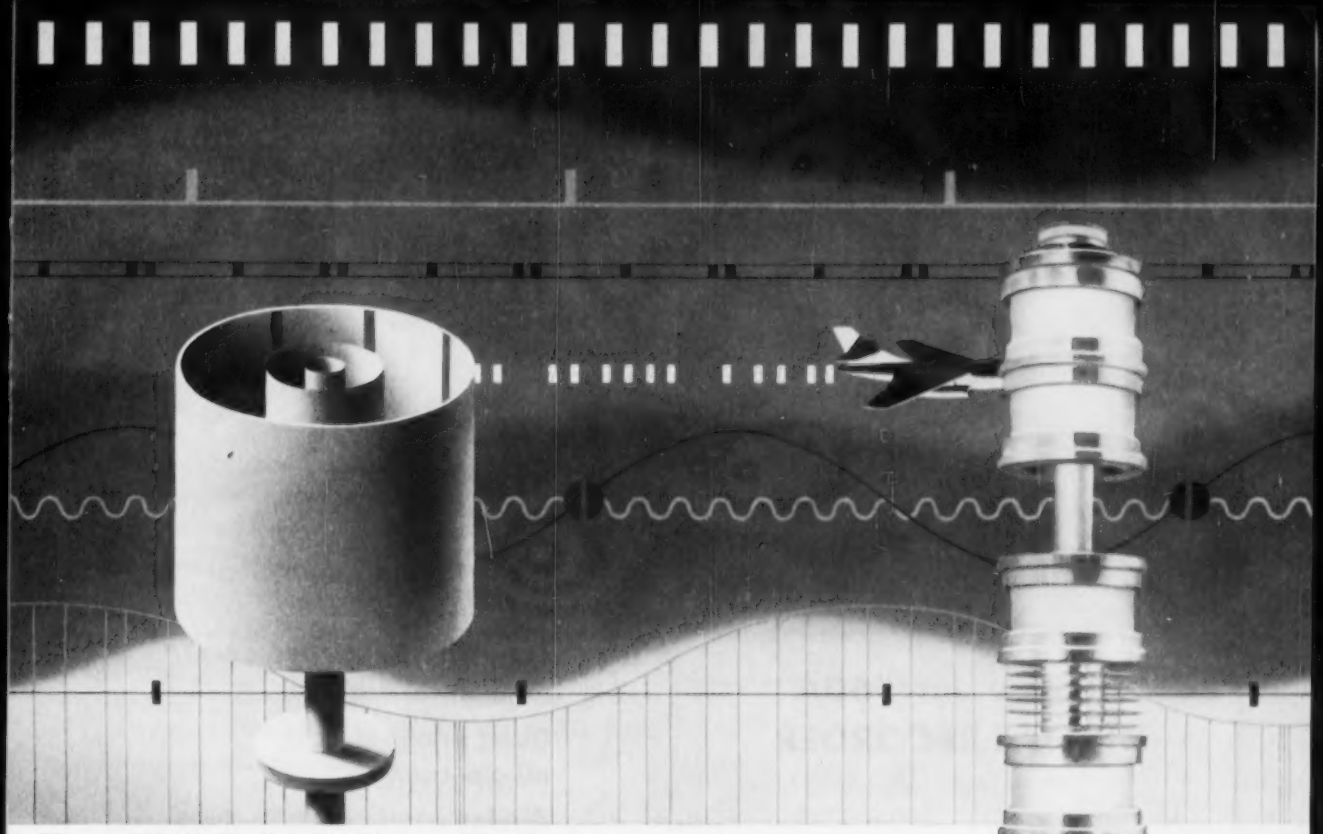

Eimac X676 Modulating Anode Klystron

Shaped RF Pulse, 30 KW Peak Power Output for 955-1220 mc Air Navigation Systems

Designed for air navigation systems, the Eimac X676 three cavity, air cooled klystron will deliver 30 KW peak power output in the 955 to 1220 mc range. With a power gain of 35 db, this tube has an efficiency of 40 per cent.

A typical air navigation systems requirement is a shaped RF pulse output to eliminate spectrum interference in adjacent channels. The Eimac X676 conservatively meets the 60db requirement of the CAA's air navigational system without using critically tuned, expensive filters in the RF output transmission line. The modulating anode permits pulsing the beam current while keeping the accelerating voltage constant. Also, the modulator circuit for this application is quite simple.

The RF cavities are external to the vacuum system and detachable from the klystron. The user may purchase spare tubes without buying additional tuning and focusing assemblies.

For the design engineer, the features of the X676 simplify circuitry – for the equipment operators the X676 provides reliable, long-lived performance at moderate cost.

For further information about the Eimac X676 Modulating Anode Klystron, consult our Application Engineering Department. Also available are two highly informative booklets; "The Care and Feeding of Klystrons" and "Klystron Facts . . . Case Four".

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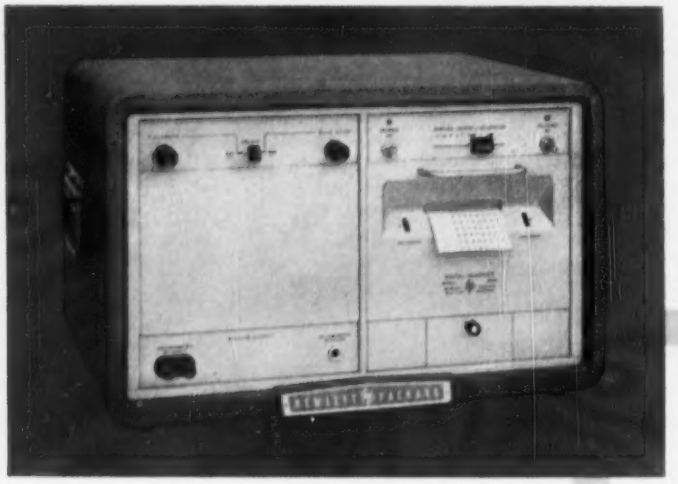
***Eimac First* in high power amplifier klystrons**

Eimac

Typical Pulse Operation X676

DC Beam Voltage	24 KV	Power Output	32 KW	Power Gain	35 db
DC Beam Current	3.3 Amps	Driving Power	10 watts	Average Power	1 KW
Power Input	80 KW	Efficiency	40%		

New, compact, convenient!



Continuous

All new -*hp*- 560A DIGITAL RECORDER

Prints 11-digit information at 5 lines per second

Controlled by electronic or mechanical devices

Direct print-out from all -*hp*- counters

Analog output for strip-chart recorder

Expanded scale; full scale can represent $1/10^7$

Accuracy identical to that of counter used

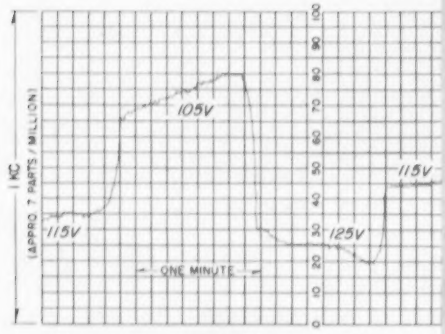


Figure 1. Frequency stability vs. line voltage; 150 MC oscillator

SPECIFICATIONS

Accuracy: Identical to that of basic counter used.

Printing Rate: Controlled by counter, 5 lines/sec. max.

Digit Capacity: 11 digits per line (also 6 digits per line).

Driving Source: Parallel entry staircase voltages derived from standard digital frequency counters such as Hewlett-Packard types. Staircase descends from +135 v to +55 v as the count progresses from 0 to 9. Internal impedance of staircase source should be approximately 700,000 ohms.

Paper Required: Standard 3" roll or folded paper.

Line Spacing: Single or double, adjustable.

Analog Signal: Any three consecutive digits may be selected by selector switch. Output is function of selected digits. For example, if consecutive digits were 3, 8, and 6, output voltage would be 38.6 millivolts or 0.386 ma.

Print Command Signal: 1 μsec or greater, positive or negative pulse, 15 volts p-p or greater.

Output Available: 1 milliamp for galvanometer strip-chart recorders. 100 millivolts for potentiometer strip-chart recorders.

Power: 105/125 volts, 60 cycles, 250 watts.

Dimensions: Cabinet Mount: 20½" wide, 12½" high, 18½" deep. (Rack Mount available.)

Weight: Net 60 lbs. Shipping 100 lbs.

Accessories Available: 1052-24, 3" folded paper, 48/carton.

Price:

-*hp*- 560A, Cabinet Mount, 11-digit operation, $1,390.00
-*hp*- 560AR, Rack Mount, 11-digit operation, $1,375.00
-*hp*- 560A, Cabinet Mount, 6-digit operation, $1,265.00
-*hp*- 560A, Rack Mount, 6-digit operation, $1,250.00

Data subject to change without notice. Prices f.o.b. factory

World leader in electronic

digital record for frequency counters!

Here—ready to save your time now—is a totally new kind of digital recorder designed from the chassis up for maximum speed and convenience and utmost versatility.

The new -*hp*- 560A works directly with all -*hp*- counters; no intermediate equipment is required. It will provide a complete record of the full output of any counter up to a speed of 5 times per second. Thus it is possible to have a complete written record of all kinds of test data, plus a convenient graphic record of very small data variations through the analog feature.

Analog Output

The 560A's analog output for driving a strip chart recorder is a voltage or current proportional to the number represented by any three consecutive digits of recorded data. The instrument permits expanded scale strip chart recording and the strip chart can never be driven off scale since range variation for the 3-digit scale is 0 to 999. Wider variation results merely in a repetition of the 0 to 999 sequence.

Counter Accuracy

Model 560A is a complete electronic measuring instrument normally controlled by staircase voltages and a print command pulse from an -*hp*- counter. It may also be controlled by other electronic or electro-mechanical devices. Since -*hp*- 560A is literally a slave to its associated counter, accuracy is identical with that of the counter. Printing speed of five, 11-digit lines per second is available; and secondary or coding data may be entered simultaneously with primary data.

A modified version of -*hp*- 560A with a print capacity of five, 6-digit lines per second is also offered.

Operation

In operation, a command pulse initiates a scanning cycle during which the number wheels are positioned by staircase voltages from the counter decades (see Figure 2). At the end of the scan cycle, a print of the data is made, and the paper automatically advanced to display the count.

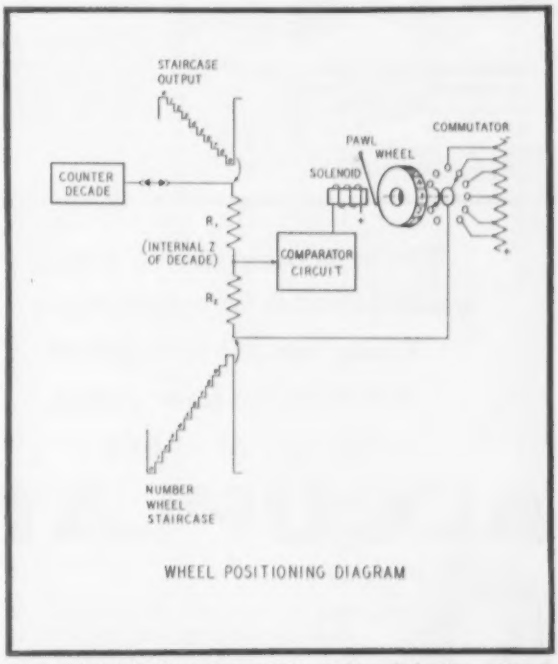


Figure 2. Principle of recorder operation. At the end of each counting period, the staircase voltage generated comes to rest on a step corresponding to the digit displayed by that decade. The number wheel rotates, generating its own staircase. At voltage coincidence, the number wheel is positioned by comparator and solenoid.

For complete details, see your -hp- *representative or write direct*

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4276A PAGE MILL ROAD • PALO ALTO, CALIFORNIA, U.S.A.
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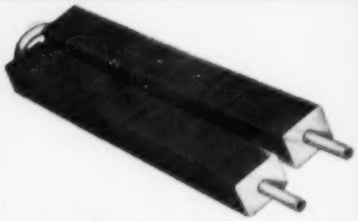
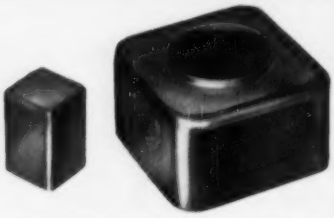
test instrumentation

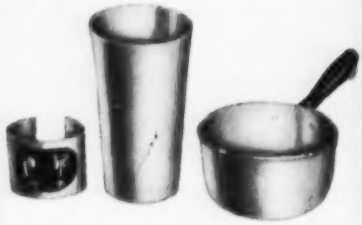


HEAT TRANSFER UNITS — ALCUPLATE provides ideal fin sections at reduced cost over solid copper fins. The copper surface permits soft soldering of the fins to the tubes.

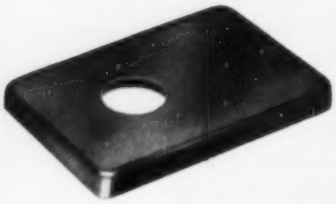


COMPONENT CASES — ALCUPLATE is successfully drawn and formed into lightweight cases or cans and intricate parts . . . ideal for hermetic sealing.

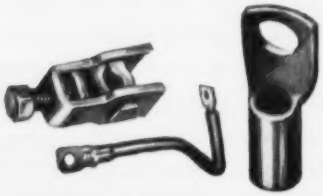
BUS BARS — ALCUPLATE provides high conductivity, light weight, solderability . . . is lower in cost than solid copper bus bars.



DRAWN AND FORMED PRODUCTS — ALCUPLATE, with its pleasing appearance, is an ideal metal for giftware and gourmetware.



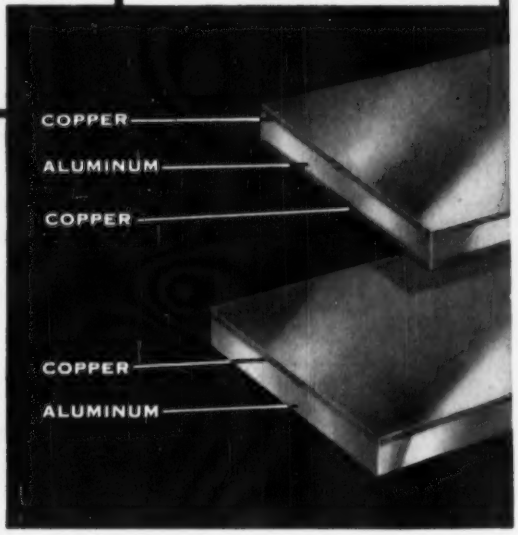
ELECTRONIC CHASSIS — ALCUPLATE offers the advantages of minimum weight plus the copper surface needed for soft soldering, electro-plating and low-resistance shield connections.



ELECTRICAL TERMINALS — ALCUPLATE eliminates galvanic corrosion which otherwise results from aluminum and copper junctions.

These products have something in common — They're all made of versatile, low cost General Plate

ALCUPLATE®



General Plate ALCUPLATE is a clad metal made by bonding solid copper on one or both sides of aluminum.

The copper surfaces of G. P. ALCUPLATE have all of the properties of solid wrought copper, but when bonded to the aluminum, there is a substantial reduction in overall weight, with cost savings of up to 30%.

G. P. ALCUPLATE is available in coils or cut lengths, in thicknesses up to 1/16" and widths up to 14". Thickness ratios can be supplied up to 10-90 in single clad, or 10-80-10 in double clad.

G. P. ALCUPLATE is an excellent thermal and electrical conductor. It is easily formed, deep drawn, or spun, and it offers ideal surfaces for fine finishing.

Write today for complete details on versatile G. P. ALCUPLATE — ask for Bulletin 702E.

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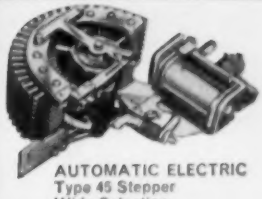

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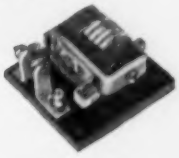
Wide Selection



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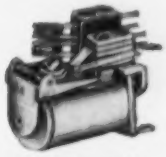

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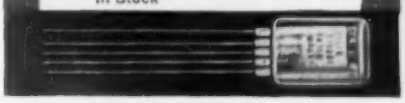

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Sub Miniature Hermetically Sealed Relay. All Advance Types in Stock

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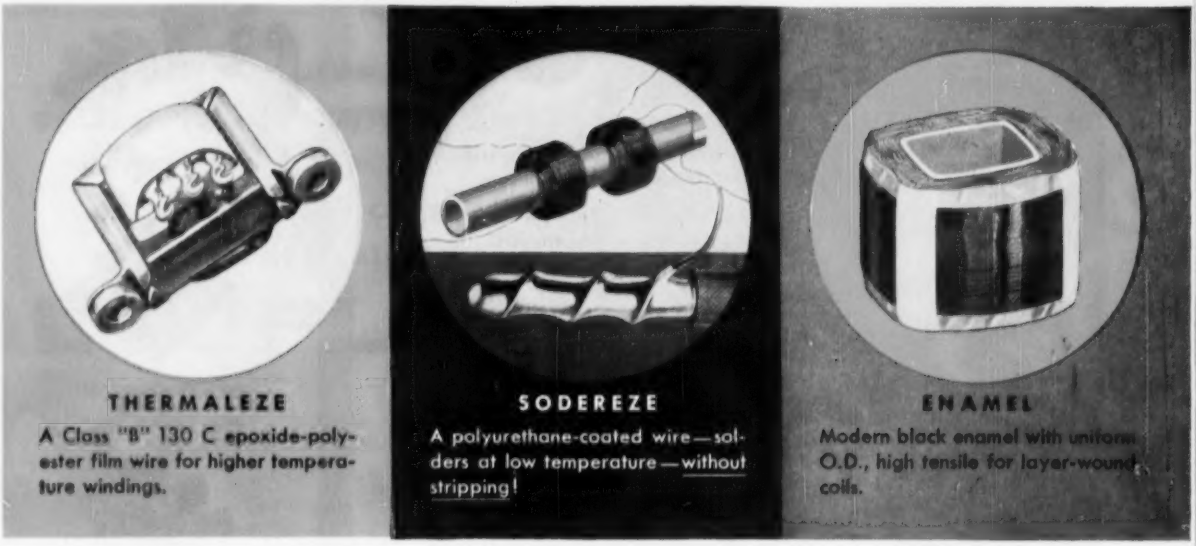
Unusual Shapes?...

Space?...

Here are five proven solutions to



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A Class "B" 130 C epoxide-polyester film wire for higher temperature windings.

SODEREZE

A polyurethane-coated wire—solders at low temperature—without stripping!

ENAMEL

Modern black enamel with uniform O.D., high tensile for layer-wound coils.

First for Lasting Quality—from Mine to Market!

Coil Problem?...

Phelps Dodge can supply the right answer to your particular magnet wire problem from its complete, up-to-date line. The products shown here have varied electronic applications. These magnet wires are the result of Phelps Dodge research and development of new materials, combined with practical experience in application engineering.

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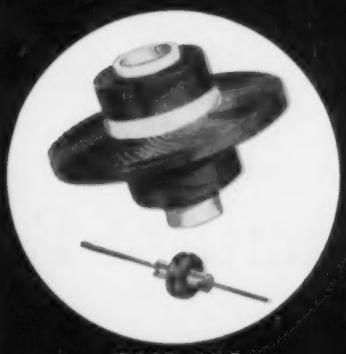
Daglas® • Daglas® Silicone • Paper • Cotton • Multiple Combinations

lower-cost electronic coils

BONDEZE

Self-bonding wire for turn-to-turn bonding in unusual shaped coils, bobbinless coils, yoke coils, etc.



GRIP-EZE

Controlled friction solderable film wire for winding universal lattice-wound coils, fly-back coils, choke coils, etc.

Wire packaged in Phelps Dodge special "Pakeze" containers if required.

Any time magnet wire is your problem, consult Phelps Dodge for the quickest, easiest answer!

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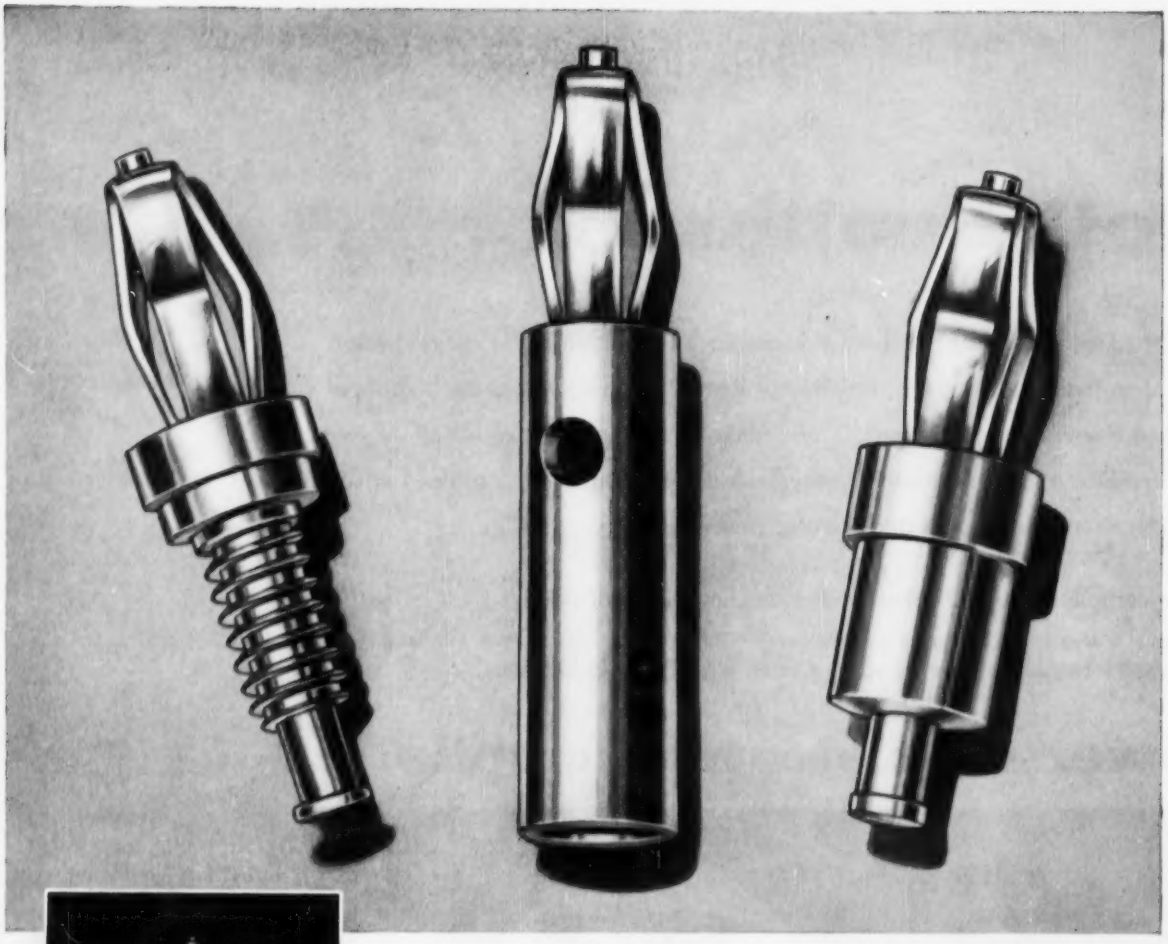
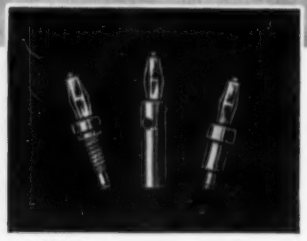


6 times enlargement



Actual size

Ucinite Miniature Banana Pins

Heavy resistance to torque is a big feature of Ucinite miniature banana pins. The springs are mechanically riveted over and the large area around the tip of the pin is bonded by solder.

Pins are available in a variety of types, for assembly by staking . . . with nuts and washers . . . with soldered tails . . . with multiple plug-in features. Springs are designed to fit .093 sockets.

Built to withstand rough usage, Ucinite miniature banana pins are available in cadmium, silver or gold plate.

For further information, call your nearest United-Carr representative or write directly to us.

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The UCINITE CO.

Newtonville 60, Mass.

Division of United-Carr Fastener Corp.

Specialists in

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THREAD CUTTING FASTENER
HOLDS TIGHT TO CURVED SURFACES

- Low Cost
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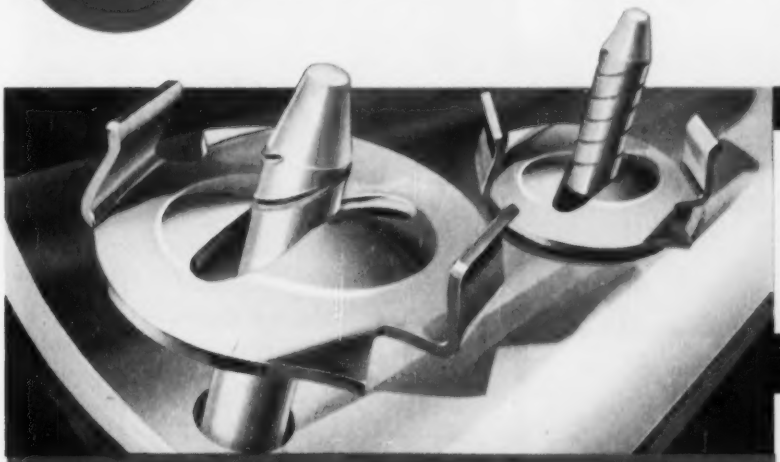
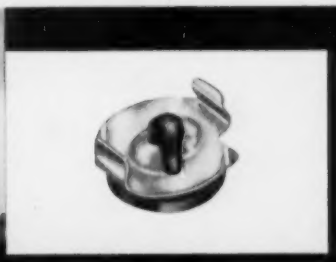
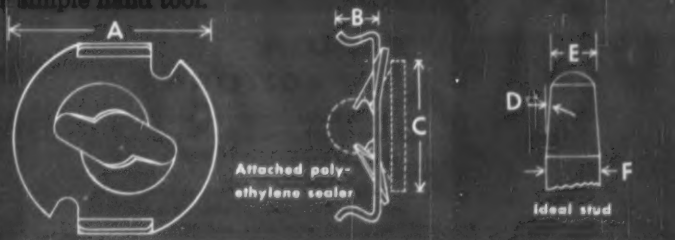




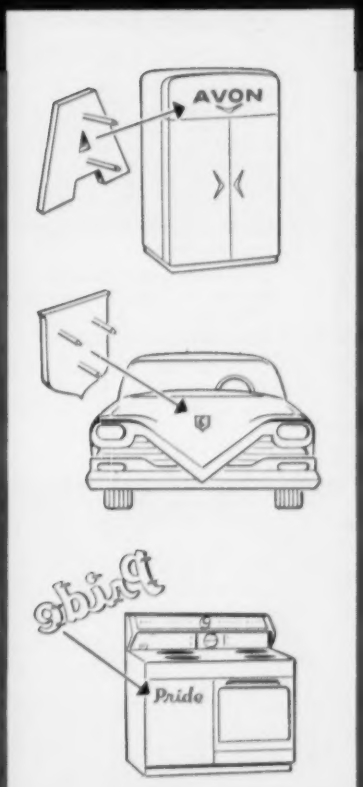
Specially designed to hold die-cast or cold-forged name plates, emblems and trim against sheet metal surfaces . . . DOT'S unique T.C.F. can be used in many other applications which require a spring take-up fastener that pulls up tight without backup on flat or contoured surfaces.

It cuts clean, deep threads on unthreaded studs, even those that are chrome plated. When used with its preassembled plastic sealer, T.C.F. makes a water-tight seal. The sealer *precedes* the fastener onto the stud so that it is not damaged by the thread-cutting process.

Available *in quantity*, with or without sealer, to fit 1/8" and 3/16" studs. Drawings available on request for magnetic tool or simple hand tool.



Nominal Sizes	A	B	C	D	E	F	Driving Torque	Ultimate Strength
1/8"	.560	.170	.450	6°/4°	.095 .085	.130 .125	7-10 Inch lbs.	200 lbs.
3/16"	.705	.200	.450	6°/3°	.160 .150	.192 .184	20-30 Inch lbs.	400 lbs.



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DOT T.C.F.
Patent Pending

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Glass cased capacitors for A.C. applications such as bridge arm elements, filter network components, standards of capacitance; for R. F. tank circuit applications, for D.C. applications in storage circuits, electronic computers, and other critical circuitry.

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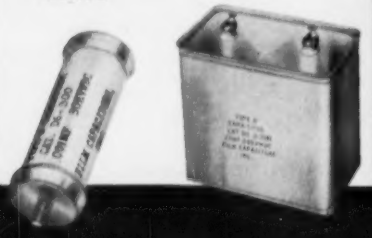

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Equivalents available for Condenser Products Series TAC, TACM and TAG

Look to F C I — Film Capacitors, Inc. — as your new source of supply for capacitor types equivalent to Condenser Products types. You can be sure of the high quality and outstanding electrical properties of the F C I product. It has been proven time and again in the most critical applications.

Non-standard capacitors for prototype requirements are available at short notice.

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If your installation requires a workhorse electrical connector, and there isn't room for a mouse, don't wring your hands and sob. Perk up and smile, because there's a giant-hearted midget that'll do the job . . . a Deutsch Push-Pull Miniature Connector.

Tiny, trustworthy and tamperproof, the Push-Pull is the connector of choice where the problem is size . . . where the connection is blind, remote or ballistic . . . where the installation is crowded.

Operation's as simple as it's positive. Simply push in to connect, automatically lock and seal. Pull back for instant disconnect. No twisting, turning or lockwiring. Just push-pull . . . all in a straight line.

We've a brand new catalog (Bulletin 501) that describes and illustrates our complete line of miniature connectors. If you let us know where, we'd be pleased to send you a copy.

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Los Angeles 3, California

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Section of department making stators for Bendix synchros and motors

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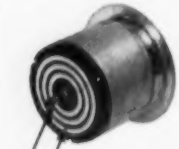
EXTERNAL SLIP RING AUTOSYNS®

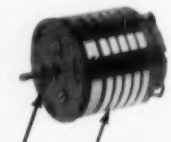
Bendix external slip rings replace ordinary fixed leads where it is desired to rotate the stator in addition to, or instead of, the rotor. Individual mechanical and electrical requirements determine location and configuration of these external rings.

As can be seen from the few examples below, many variations are possible in Bendix External Slip Ring Autosyns.



Three external stator rings in face of Autosyn.

Two external rotor rings.



Rotor and stator rings mounted concentrically with outside diameter of housing.

Rotatable gear mounted to Autosyn.

Rotor and stator take-offs are by means of brushes riding on these external rings.

Fast delivery of practically any type synchro at minimum cost. Isn't that what you want from your synchro supplier?

If so, consider how well Bendix fills the bill. First, as a virtual "supermarket" for synchros, we maintain mass production that means minimum unit prices, even to small-quantity buyers. Second, we produce virtually all types of synchros as *standard items*, meaning you can get delivery fast —*immediately*, in most cases.

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Let our vast experience and mass production facilities go to work on *your* synchro needs, too!

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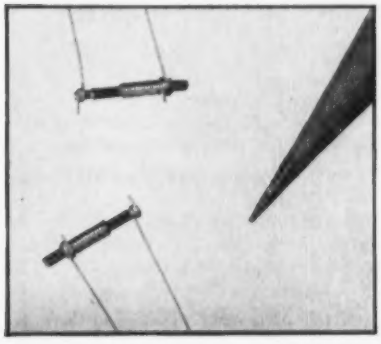
ELECTRONIC DESIGN NEWS

LATEST PROPERTY AND APPLICATION DATA ON TEFLON® tetrafluoroethylene resins

Remarkable properties of Du Pont TEFLON® resins provide rugged, low-loss insulation for wiring

Use of TEFLON® promotes miniaturization of electronic parts

Owing to the high dielectric strength of Du Pont TEFLON—ratings are 500 to 4,000 volts per mil—insulation on wires can be exceedingly thin. Hence the heating due to current overload, which is always a critical factor with thin conductors, has less of an effect on TEFLON than on any other wiring insulation. Because TEFLON can operate hotter, it permits many miniaturization projects which would not be feasible without it. Miniaturization of coils, capacitors, brushes and other components is frequently possible because of the remarkable properties of wire insulated with TEFLON. TEFLON has opened up new fields of use for magnet wire, hookup wire, lead wire, coaxial cable and resistance wire. Tubing of TEFLON is available down to hairlike diameters. The coupon will bring more information.



These small capacitors use TEFLON as the dielectric. Their degree of miniaturization is shown by comparison with end of lead pencil.

Secony Mobil photo

"Datatron" solves the complex numerical problems of modern industry and commerce. Intricate wiring of the electronic computer is protected by slip-on insulation of Du Pont TEFLON 6 tetrafluoroethylene resin. (Computer by ElectroData Corporation, Pasadena, Calif., "spaghetti" tubing supplied by Pennsylvania Fluorocarbon Co., Inc., Philadelphia, Pa.)

Designers of the Datatron high-speed digital computer took no chances with ordinary wiring insulation. Heat generation in this equipment cannot damage or age the sleevings of Du Pont TEFLON used to protect the conductors. TEFLON retains its toughness, flexibility and electrical characteristics to a rated 500°F. Soldering-iron temperatures will not burn or melt insulation of TEFLON. In assembly operation, TEFLON does not undergo shrinkage during soldering.

Other properties of this remarkable engineering material are often equally valuable in electronic devices. The arc resistance of TEFLON tetrafluoroethylene resin is outstanding. Its power factor of less than 0.0003 from 60 cycles to 3,000 megacycles guarantees low dielectric losses in high-frequency equipment. The volume resistivity of TEFLON is greater than 10^{18} ohm-cm, even after prolonged soaking in water. Surface resistivity is greater than 10^{17} ohms at 100% relative humidity. Applications are often based on the exceptionally low coefficient of friction of TEFLON. For example, "spaghetti" tubing is easily slipped over long conductors. Parts made of TEFLON will pass any salt-spray test. In fact, TEFLON is one of the most chemically inert materials known. Many electronic products depend on TEFLON to meet stringent MIL specifications.

The components you specify or design may well be improved by the use of protective, durable TEFLON. Further information can be obtained by mailing the coupon.

TEFLON®

is a registered trademark...

TEFLON is the registered trademark for Du Pont tetrafluoroethylene resins, and should not be used as an adjective to describe any other product or any component part; nor may this registered trademark be used in whole, or in part, as a trade name for any product.

SEND FOR INFORMATION

For additional property and application data on Du Pont TEFLON tetrafluoroethylene resins, mail this coupon.

E. I. du Pont de Nemours & Co. (Inc.), Polychemicals Dept.
Room 1751, Du Pont Building, Wilmington 98, Delaware.

Please send me more information on Du Pont TEFLON tetrafluoroethylene resins. I am interested in evaluating this material for _____

Name _____

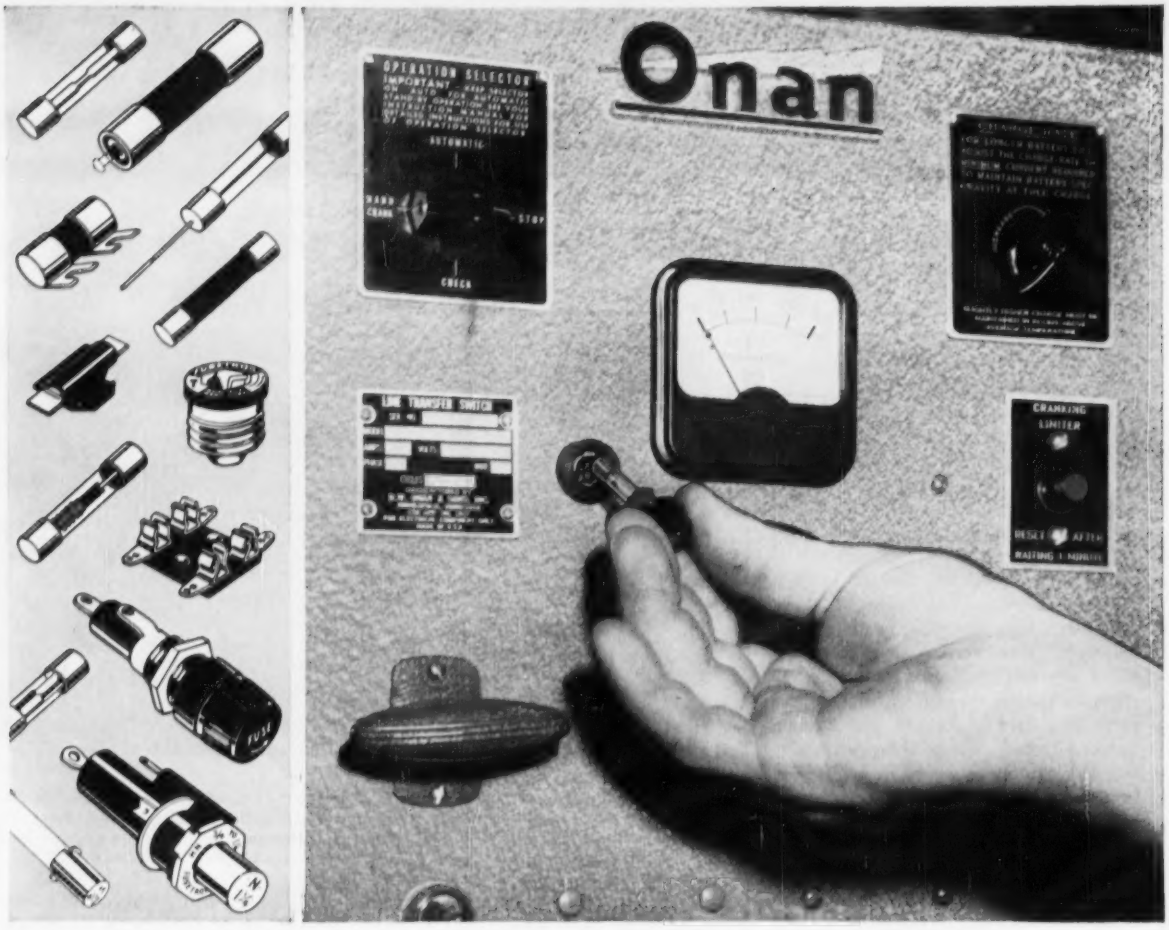
Company _____ Position _____

Street _____

City _____ State _____

Type of Business _____

In Canada: Du Pont Company of Canada (1956) Limited, P. O. Box 660, Montreal, Quebec



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George Thole, CHIEF CONTROL DESIGN ENGINEER
D. W. ONAN & SONS INC., MINNEAPOLIS, MINNESOTA

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"It is essential that our units operate properly in this emergency otherwise there would be a plant shut-down and the possibility of damaged equipment and property. In some cases human lives would be in danger.

"You can see why all the components used in our equipment must meet the very highest standards for dependability.

"Fuses are an integral part of the battery charging circuit which is incorporated into our line transfer controls.

"In fuses, we have found by experience that BUSS Fuses can be depended upon to meet the standards of reliability that are required by our stand-by power units."

You, too, can profit by standardizing on BUSS fuses.

The unfailing dependability of BUSS fuses helps keep equipment operating properly. Whereas, faulty fuses might cause needless burnouts or useless shutdowns,—BUSS fuses can be relied on to operate properly under all service conditions.

To meet your needs, there is a complete line of BUSS and Fusetron fuses, . . . plus a companion line of fuse clips, blocks and holders.

For more information on BUSS and FUSETRON Small Dimension fuses and fuseholders . . . Write for bulletin SFB. Bussmann Mfg. Co. (Division of McGraw-Edison Co.) University at Jefferson, St. Louis 7, Mo.

BUSS fuses are made to protect—not to blow, needlessly

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- Gets leads to the printed circuit board in one assembly operation;
- Eliminates an investment in expensive automation equipment;
- Can be applied to solid or stranded wires;
- Eliminates danger of shorts due to "solder-bridging" of insecure leads;
- Has construction details that promote good capillary flow of solder during the dipping process;
- Is self-retaining, with no damage to the printed circuit board during pre-assembly operations;
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Write today for additional information on the NEW A-MP SNAPIN, *the* AMP-EDGE *Connector and other A-MP products designed for printed circuit applications.*

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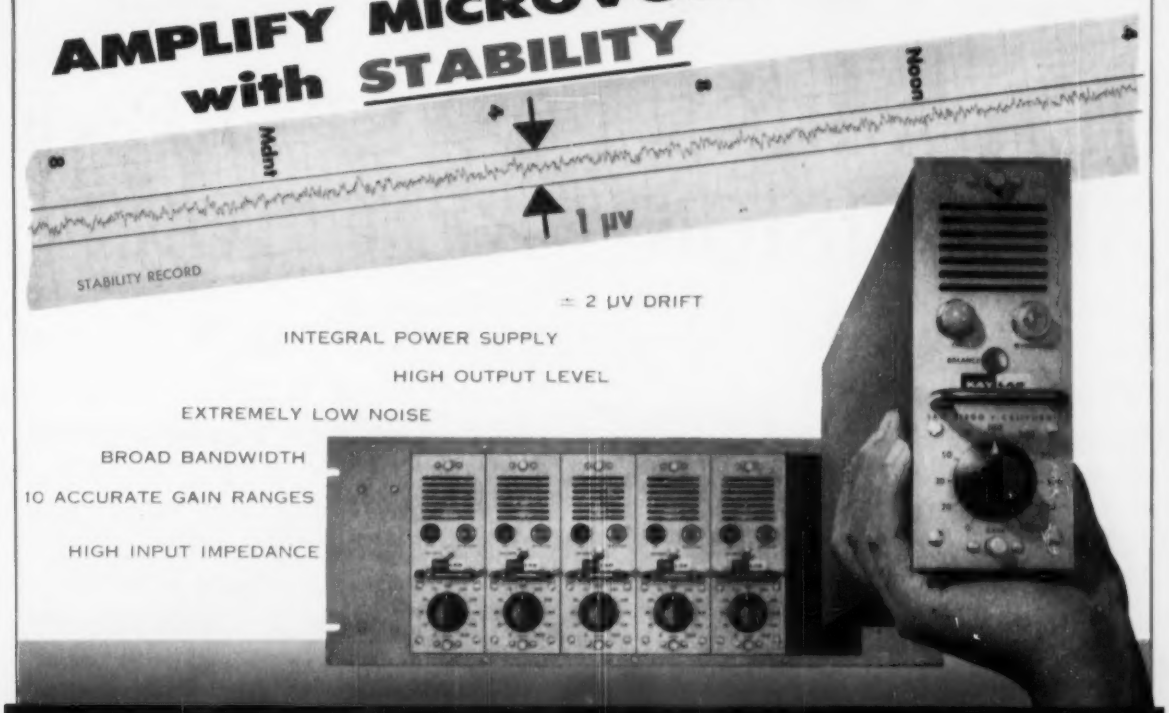
KINTEL [KAY LAB]

FOR DRIFT-FREE DC INSTRUMENTATION

AMPLIFY MICROVOLTS with STABILITY



The **KINTEL** Model 111 amplifier provides maximum stability and the lowest drift of any commercially available broadband d-c amplifier. It is the end result of years of research in the field of chopper stabilized broadband d-c amplifiers. Thousands of **KINTEL** amplifiers are in daily use.

The Model 111 incorporates **KINTEL's** proven chopper amplifier circuitry and provides ten extremely precise, feedback controlled gain ranges. Several feedback loops assure high accuracy, stability and uniform frequency response. The completely new and unique circuit provides rapid recovery from severe overloading and unsurpassed dynamic performance – unaffected by load or gain changes.

The Model 111 is available in a single-unit cabinet or in a six-unit rack-mountable module. The amplifiers are extremely compact; the six-unit module occupies only a 19-inch rack width.

APPLICATIONS: The Model 111 is ideal for permanent low level d-c instrumentation, telemetering, or as a strain gage amplifier, transducer amplifier, scope preamplifier, recorder driver amplifier, or general purpose laboratory amplifier.

SPECIFICATIONS

Gain	0, 20, 30, 50, 70, 100, 200, 300, 500, 700, 1000
Gain Accuracy	± 1% DC to 2 KC
Input Impedance	100,000 Ω
Output Capability at DC	0 to ± 35 V where R_L > 1000 Ω 0 to ± 40 MA where R_L is 10 to 400 Ω
Output Impedance	Less than 1 Ω in series with 25 μh
Equivalent Input Drift	± 2 μv with regulated line
Equivalent Input Noise	0 to 3 cps, less than 5 μv peak to peak 0 to 750 cps, less than 5 μv RMS 0 to 50 kc, less than 12 μv RMS
Chopper Intermodulation	Less than 0.1%
Linearity	Better than 0.1% to 2 KC
Frequency Response	± 3% (0.3 db) DC to 10 KC, less than 3 db down at 40 KC

Power Requirements:	
Amplifier	117 V – 60 cycles – 70 VA
Cabinet	117 V – 60 cycles – 15 VA
6 Unit Rack Adaptor	117 V – 60 cycles – 45 VA
Dimensions: Amplifier Unit	2⅞" wide, 7⅞" high, 14⅝" deep
Rack Adaptor for 6 Units	19" wide, 8¾" high, 18¼" deep
Net Weight – Amplifier	11 pounds
PRICE: Amplifier Unit	$550.00
19-inch Rack Adaptor for 6 amplifier (with fans and connectors)	200.00
Cabinet for single amplifier (with fan and connector) is available.	

...the Standard in chopper-stabilized instruments

STABILITY *locked in!*

WITH CHOPPER AMPLIFIERS

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ULTRA-HIGH POLYSTYRENE PRECISION CAPACITORS

as low as 0.1% tolerances in most values!

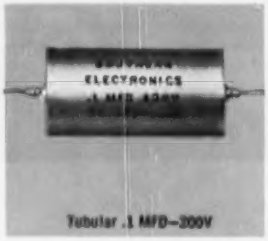
Leading engineers know that S. E. C. pioneered the current polystyrene capacitors in Guided Missiles and Analog Computers. S. E. C. test data and engineering experience is based on years of research and constant improvement of product.

S. E. C. products have proved the answer to many tough engineering problems by such leading *analog computer manufacturers as;* Electronic Associates, Reeves Instrument, Beckman Instrument, Mid-Century Instrumatic, Goodyear Aircraft, Donner Scientific, Boeing Airplane Company and such *military contractors* as Northrop Aircraft, Gilfillan Brothers, North American Aviation, Convair, Motorola, Farnsworth Electronics, Bendix Aviation, Federal Tele-Communications and many others.

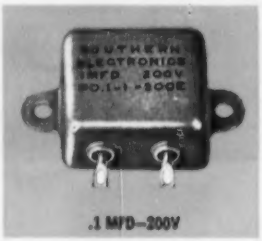
R. & D. establishments as M.I.T., Jet Propulsion Labs, Cornell Aeronautical Labs, Battele Memorial Inst., Sandia Corp., and many others have chosen S. E. C. engineered components for their prototypes.

Check these outstanding features for yourself:

- Tolerances as close as 01%
- Insulation Resistance as HIGH as 1×10^{12}
- Dielectric Absorption as LOW as .0001
- Dissipation Factor as LOW as .0002
- Temperature Coefficient...100 PPM per °C.
- Stability as close as .05% drift in 1 yr.
- Voltage derating . . . none to 170° F.
- *Hermetically sealed for enduring accuracy!*



Tubular .1 MFD—200V


.1 MFD—200V

10 MFD ±1% 200V
4-7/16 x 3-1/16 x 2-1/8

1 MFD—200V

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Burbank, California

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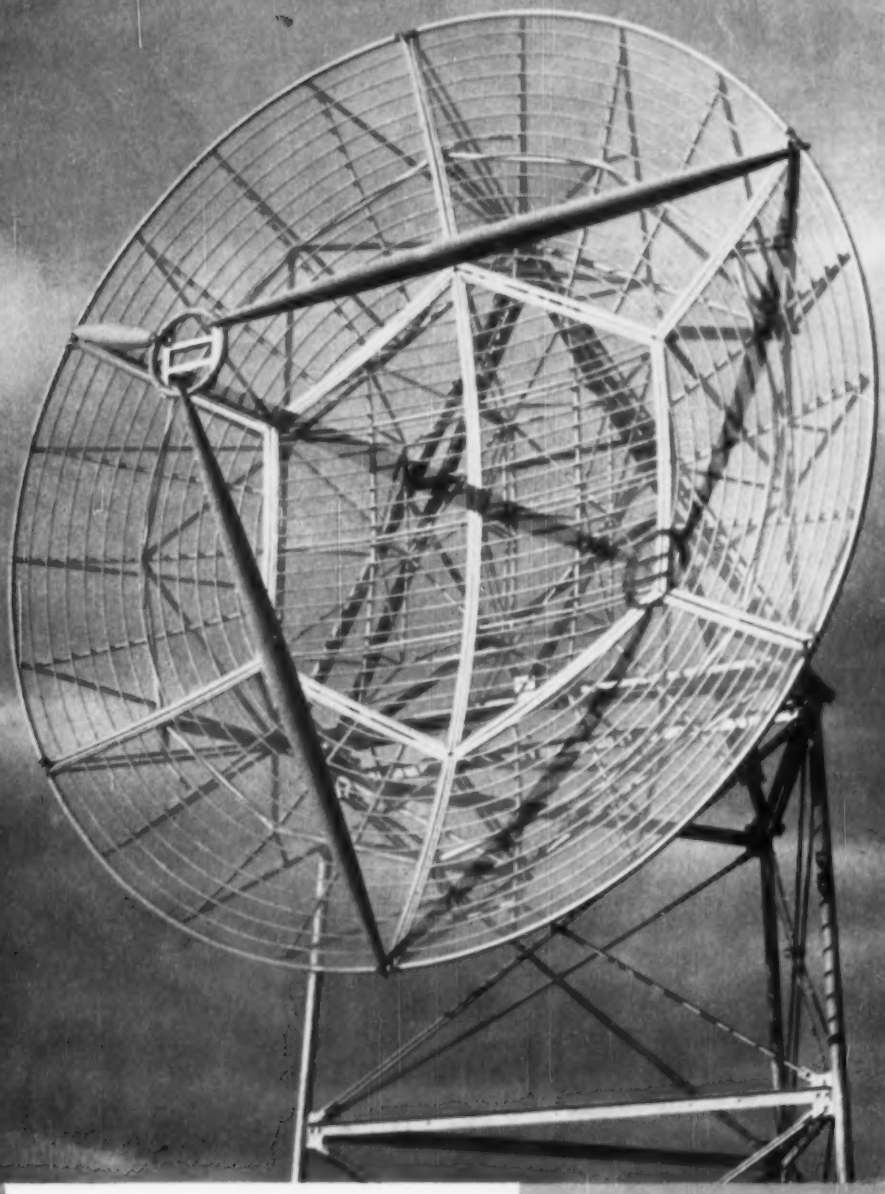
KENNEDY INTRODUCES

the 28 foot "TUF-SCAT" *antenna*



This new scatter antenna is specifically designed for the world's toughest weather conditions. Recently static load tested with over 32 tons (105 lbs./sq. ft.) on its surface, this big dish and tower have been carefully engineered and constructed to withstand winds in excess of 150 M.P.H. Even a 6" layer of ice won't disturb its performance. It is, in fact, the most rugged aluminum antenna ever built. Yet, its light weight, sectionalized aluminum construction keeps shipping costs down, makes assembly easy.

Want more information? Use post card on last page.

ANTENNA EQUIPMENT

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Tracking Antennas - Radio Telescopes - Radar Antennas - "Trans-Horizon" Antennas: Ionospheric Scatter - Tropospheric Scatter

NEW NORTHERN RADIO REGENERATIVE REPEATER

for teleprinter, half duplex and synchronous binary operation

Type 207 Model 1
the most advanced in the industry!

The new Northern Radio Regenerative Repeater is designed for use in telecommunication circuits to re-shape and re-time distorted signals for local use or retransmission. Special provision has also been made for use of this unit on half duplex circuits — where it will not only regenerate the ordinary teleprinter signals but also faithfully reproduce such special signals as "break" signals and "mark restoration" information.

Further provision has been made for use of this Regenerator with synchronous binary signals on either single channel circuits or multi-channel time division multiplex systems. Provision is made to synchronize this unit from an external source.

- **Maximum Acceptable Signal Distortion:** new circuitry accepts up to 47% mark or space distortion.
- **"Floating" Input & Output Circuits:** completely electronic output, no relays.
- **Greater Timing Circuit Stability:** time base derived from highly stabilized L-C oscillator.
- **Switch Selection of Speeds:** 60, 75, 100 words per minute.
- **Adaptable to Any Speed:** low-pass filter & frequency-determining elements are plug-in units.
- **Completely Self-contained:** includes power supply and line battery.
- **OTHER OUTSTANDING FEATURES:**
  - — faithfully reproduces "break" signals
  - — transmits "break" signal in case of line failure
  - — protected against "space lock-out"
  - — output can be open-circuited with no excessive rise in line voltage & no harm to the Repeater
  - — 22 front panel test points for equipment function and 8 jacks for input & output line, equipment, current and voltage measurements

Input Keying Signal Requirements:	(1) Neutral keying, positive or negative sense (a) on-off 60 ma pulses (b) on-off voltage pulses 10-100V into 100K ohms (2) Polar keying (3) Dry contact keying
Frequency Stability of Time Base Generator:	Less than 1 point range less for ± 10% line voltage variation or ± 20° C ambient change from 25° C
Sampling Time:	Approximately 50 microseconds
Output:	Electronic tube outputs: (a) neutral 65 ma max. into 2K ohms (b) polar 33 ma (max.) into 2K ohms
Output Distortion:	(a) Signal bias distortion less than 0.5% (b) Signal element random jitter less than 1% (c) Signal history (duty cycle) distortion less than 0.5% (d) Total distortion less than 2%
Power Requirement:	125 watts approx: 110/220V, 50/60 cps
Mounting:	Standard 19" rack mounting, 5¼" panel

Write for free 67-page catalog.

Pace-Setters in Quality Communication Equipment

NORTHERN RADIO COMPANY, inc.

147 WEST 22nd ST., NEW YORK 11, NEW YORK

In Canada: Northern Radio Mfg. Co., Ltd., 1950 Bank St., Billings Bridge, Ottawa, Ontario.

having your ups and downs?

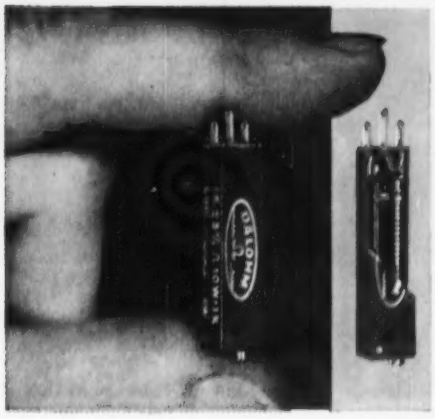
. . . if they involve POTENTIOMETERS

DALOHM has the answer!

All Dalohm components are carefully designed and skillfully made to assure you of supreme quality and dependability, plus the widest versatility of application. These recent additions to the Dalohm line already have met with wide acceptance and enthusiasm:

DALOHM Ω ®

You can depend on DALOHM



Mil-E-Trized A10-W TRIMMER POTENTIOMETER

Wire Wound, High Temperature, Humidity-Proof, Ruggedized

This Dalohm Trimmer is designed to meet the ever-increasing requirements of such specifications as MIL-E-5272A and MIL-R-12934. It provides precision adjustments in critical electronic circuits under extreme environmental conditions. It has an extended winding surface and assures high precision resolution without sacrificing sub-miniature design. Size is .220 x .310 x 1.250; weight is 2.25 grams.

- Resistance values 10 ohms to 100,000 ohms; standard tolerance 5%; power rating 0.8 watt; temperature coefficient of wire 0.00002/Deg. C. Other resistances, tolerances, leads available on special order.
- Completely sealed; housing of thermo-setting, glass filled material with heat resistance of 200° C continuous. Precious metal plating on all terminals; air evacuated and filled with silicone grease.
- Unique new type sliding contact; unique safety clutch.
- Unit holds set resistance values.
- Mounting flexibility provided for either stacked or multiple arrangements.

Write for Bulletin R-32B

Mil-E-Trized DP-12 POTENTIOMETER

Built to Surpass JAN-R-19

Hermetically Sealed, Moisture-Proof, Ruggedized

Completely protected from arctic cold or tropic damp, from shock, vibration, salt-laden air and ultra-high altitude. Powered at 4 watts, the DP-12 has a power rating of 100% at 40° C, derated to 0 at 125° C. Housing and shaft of black anodized aluminum with back plate of corrosive resistant aluminum. Unit designed for back panel mounting with integral threaded base.

- Operating temperature range—55° C to 125° C. Minimum rotational life is 25,000 mechanical cycles.
- Standard resistance range 100 ohms to 40K ohms with standard tolerance of 5%. Other ranges and tolerances available on special order.
- Precision winding gives excellent linearity with 3% maximum deviation.
- Temperature coefficient of wire 0.00002/Deg. C on values of 500 ohms and up; 0.00050/Deg. C on values below 500 ohms.
- Sensitive shaft adjustment.

Write for Bulletin R-31

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Write for the complete Dalohm catalog of precision resistors, potentiometers, and collet-fitting knobs.

If none of our standard line fills your need, our staff of able engineers and skilled craftsmen, equipped with the most modern facilities, is ready to help you solve your problem in the realm of development, engineering, design and production.

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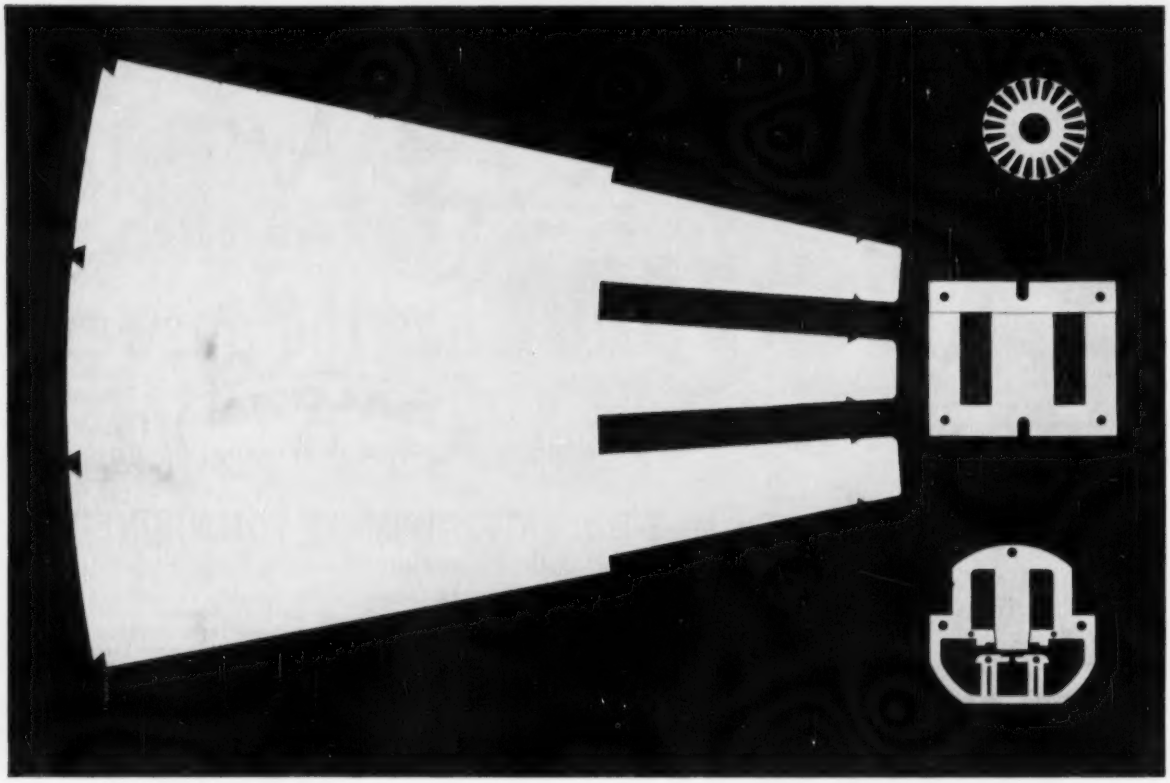

Step Up Performance, Cut Costs of Motors and Transformers

with ARMCO Di-MAX M-15

Where high efficiency is required, you can cut the production costs of equipment (from high horsepower machinery to watt-hour meters and TV transformers) with laminations made of DI-MAX M-15 coils. The reason: this special, non-oriented, low core loss Armco Steel has a unique combination of good magnetic and fabricating properties.

Advantages Offered by DI-MAX M-15

Punchability—Uniform high ductility enables you to design punched laminations of any size and shape, yet retain low core loss. DI-MAX properties extend die-life, simplify production in the shop.

Better Permeability—At high inductions the permeability of DI-MAX M-15 is better than that of the standard M-15 grade.

Improved Space Factor—Better flatness and smoother surface combine to eliminate lost space, enable you to design for maximum performance.

Available in Coils—With DI-MAX M-15 welded coils you can use all the advantages of continuous production methods. Gage is more uniform than regular M-15. And ductile, annealed butt welds are within sheet gage limits. Punching and core assembly of small or large laminations proceed as though the material had no welds.

Consider the outstanding magnetic and fabricating properties of Armco TRAN-COR DI-MAX M-15 to lower costs and step up the performance of *your* products. For complete data on this special Armco Electrical Steel, write us at the address below or call the nearest Armco sales office.

ARMCO STEEL CORPORATION

1197 Curtis Street, Middletown, Ohio

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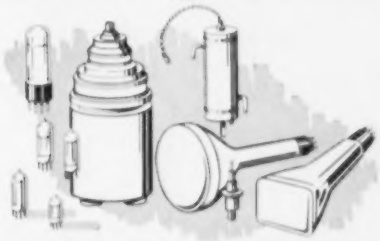
TUBE DESIGN NEWS

GENERAL ELECTRIC

RECEIVING • POWER • CATHODE RAY



7329 G-E 5-Star 6414's in IBM SAGE Computer Still Show No Opens, Shorts or Mechanical Defects after 3000 Hours Service

This huge computer, only a small part of which is illustrated, was engineered and built by IBM to serve as heart of the Semi-Automatic Ground Environment (SAGE) air defense system. G-E 5-Star 6414's in the computer had a perfect record of NO opens, shorts or mechanical defects.

No shorts, no opens, no mechanical defects . . . this is the history of 7329 5-Star 6414's that have performed in excess of 3000 hours in IBM's first XD-1 computer, engineered and manufactured for the experimental sub-sector of the USAF SAGE system.

"Out of electrical tolerance" has been the sole removal cause. In contrast: 17% of removals of another twin triode of earlier design tested in this giant computer, have been for one of the three reasons above—shorts, opens, mechanical defects—any one of which can render a tube inoperative.

General Electric's 5-Star 6414 was one of the first high-reliability tubes developed expressly for computers . . . just as G.E. previously had pioneered special tubes for commercial computers.

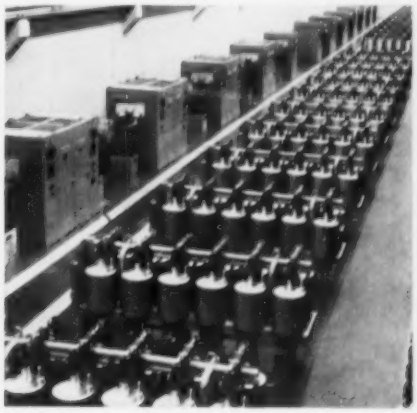
Experience not found elsewhere enters into the design, manufacture, and testing of the three General Electric 5-Star, and seven commercial computer types now available. Ask any office on the next page for further information!

Special G-E Welding Technique Makes Possible Pumpless Ignitrons with Sealed-for-Life Vacuum

General Electric pumpless ignitrons are helping industry convert a-c to d-c more economically than ever before. A continuous welding process developed by G.E. seals off the vacuum inside the tubes permanently. No pumps are needed once the tubes are installed. Doing away with vacuum pumping equipment gives cleaner installations, and leads to important savings.

One of a long series of G-E ignitron advancements, pumpless ignitrons are a General Electric "first". Today G.E. builds and offers types with the highest ratings in the field—fully able, in multiple groupings, to meet the power requirements of aluminum producers and others who are massive users of d-c.

(Continued on Page 2, Column 1)



LEFT: a continuous air-tight weld of ignitron covers to tanks is formed by rotating the big tubes in motorized jigs. RIGHT: showing a large rectifier installation of G-E pumpless ignitrons. Note the clean layout, free from vacuum pumping equipment, headers, gages, and connections. Eliminating these components saves substantially in equipment, power, and maintenance costs.

Improvements in G-E Horizontal-Amplifier Tubes Assure Full Picture Sweep, Lengthen Tube Life

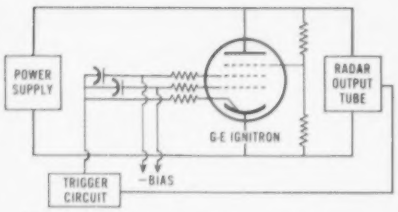
Superior sweep of G-E horizontal-amplifier tubes under low-line-voltage conditions, is demonstrated on screen at right. Large plate size and special finned or dimpled construction; advanced cathode processing; these and other features give improved performance. Tubes, moreover, are tested at factory for zero-bias plate current and plate-to-screen current ratio.

By continuously upgrading tube performance, General Electric contributes to the acceptance of today's TV sets in a market which is ever more exacting as to picture quality.

No group of G-E tubes has been improved more extensively than horizontal-amplifier types. Plate areas have been enlarged to cut plate and screen emission, causes of shrinking raster and distorted image . . . finned or dimpled plate design lessens danger of "snivets" . . . new, advanced cathode-processing techniques make for better low-line-voltage operation.

Design improvements that increase tube service life and stabilize performance include specially-processed screen grids to dissipate more heat . . . new beam plates which prevent glass deterioration from bulb bombardment . . . mica slots and mica spraying that combat inter-element leakage and arcing.

Rigid General Electric performance tests and life tests promote uniform quality for all horizontal-amplifier tubes that are built and shipped.



Trigger circuit goes into action whenever radar output tube receives an overload—actuates the ignitron, which instantly becomes a current bypass ("crowbar") in order to short out the threatened tube.

"Crowbar" Circuit Featuring G-E Ignitron Protects Radar Output Tubes From Overload Damage

Valuable use is being made of General Electric ignitrons to shield costly radar output tubes from overload damage. The ignitron is triggered to short out the tube in the event of a dangerous power surge. Such action, of course, must be virtually instantaneous—and an ignitron operates with split-second rapidity, far faster than any conventional switch.

Moreover, an ignitron will conduct current in the large amounts called for by overload protection. Type GL-6228/-506, used increasingly for this work, conducts up to 60,000 amp—yet will not fire until triggered at 65,000 v. This high hold-off voltage assures that normal variations in power will not cause circuit interruptions.

For low-power radar and broadcast stations, General Electric's GL-5630 Ignitron is a more economical, and equally popular, "crowbar-tube" investment.

Pumpless General Electric Rectifier Ignitrons

(Continued from Page 1)

A typical grouping of twelve General Electric 20-inch pumpless ignitrons, for example, will furnish up to 5000 kw of d-c power at 850 v. See the listing of 20-inch and 16-inch sizes under "New Tube-Product Briefs" at right. Consult further with any General Electric office below.

NEW TUBE-PRODUCT BRIEFS

Receiving Tubes

25EC6. New G-E beam power pentode for TV. Horizontal sweep type for 110-degree-deflection picture tubes. High performance at low line voltages. Physically shorter than 25CD6-GB, and has controlled heater warm-up for 600-ma series-string circuits.

Power Tubes

GL-6963, GL-6964. New General Electric 16-inch pumpless ignitrons for power rectification. Single-grid and double-grid respectively. Sealed-for-life vacuum.

GL-6965, GL-6966. New G-E 20-inch pumpless ignitrons, for power-rectification service. Single-grid and double-grid, with sealed-for-life vacuum.

Cathode-Ray Tubes

3ACP1, 3ACP7, 3ACP11. New G-E 3-inch flat-face C-R types for radar and oscilloscope applications. Electrostatic deflection and focus. Post-acceleration gives maximum deflection sensitivity with a high degree of brightness. Deflection structure is electrostatically shielded—this improves beam accuracy and minimizes interaction.

EASTERN REGION
General Electric Company, Tube Sales
200 Main Avenue, Clifton, N. J.
Phones: (Clifton) GRegory 3-6387
(N.Y.C.) Wisconsin 7-4065, 6, 7, 8

CENTRAL REGION
General Electric Company, Tube Sales
3800 North Milwaukee Avenue
Chicago 41, Ill.
Phone: SPring 7-1600

WESTERN REGION
General Electric Company, Tube Sales
11840 West Olympic Boulevard
Los Angeles 64, Calif.
Phones: GRanite 9-7765; BRadshaw 2-8566

Progress Is Our Most Important Product

GENERAL ELECTRIC

162-105

ELECTRONIC COMPONENTS DIVISION, GENERAL ELECTRIC COMPANY, SCHENECTADY, N. Y.

for highest accuracy . . .

PRECISION RESOLVERS

by Reeves INSTRUMENT CORPORATION

including the **NEW SIZE 11** miniature

The new Size 11 miniature resolvers, now in commercial production, compare in performance with the standard Size 23 and Size 15 Reeves units, long accepted as the precision standard of the industry. Functional accuracy of 0.05% in the Size 23 and 0.1% in the Size 15 and Size 11 are achieved in standard production without culling. Even higher accuracies can be obtained on special order.

Both compensated and uncompensated units can be supplied in any frame size. Special units are also available for use as phase shifters or for high frequency use. For the best in resolvers, bring your requirements to Reeves!

Write for resolver catalog RICO 57.

REEVES CONTINUOUS RESOLVER CHECKER

Provides continuous 360° check on resolver functional accuracy, and yields permanent record of results.

Reeves INSTRUMENT CORPORATION

7RV57

REEVES INSTRUMENT CORPORATION

A SUBSIDIARY OF DYNAMICS CORP. OF AMERICA, 201 EAST 91st ST., NEW YORK 28, N.Y.

Want more information? Use post card on last page.

Here is CONTROL!

May 1. Important news to engineers concerned with industrial control is announcement of standardized high permeability magnetic control devices now available from "Control," a division of Magnetics, Inc., Butler, Pennsylvania.

"Control's" first products are standard lines of saturable reactors. Twenty-two catalogued reactor assemblies will be stocked and are ready for rapid delivery.

Establishment of "Control" is a major step forward in permitting engineers to take full advantage of long life and ruggedness features of high permeability magnetic devices. It takes these units from the custom-order to the mass production stage with important benefits in engineering convenience and dependability.

In recent years, high permeability magnetic devices have made real inroads in the industrial control field. CONTROL reactor assemblies may be used for such diversified applications as motor control, voltage regulation, automatic battery charging, arc welding control and power amplification of the minute outputs from many types of transducers.

Engineering sales representatives are located in many key areas in the United States. Advertising appears in leading trade publications in May, based on the theme "Reliability Begins With CONTROL."

Now··CONTROL offers you standardized saturable reactors

If you're a design engineer who would be delighted with industrial components which are sensitive and, under normal operation, last virtually forever with no maintenance or servicing, then you'll welcome CONTROL's *standard* lines of saturable reactors.

With CONTROL reactor assemblies and magnetic amplifiers, you know complete physical and operating characteristics —a copy of our Catalog R-10 awaits your request. And, delivery is fast because sub-assemblies of these units are stocked, awaiting your control-winding specifications.

CONTROL reactors are available for both 120- and 240-volt 60-cycle operation. There are eleven standard sizes in each voltage range. They have extremely high gain. Six ampere-turns control nearly 2,000 watts in the largest size. Power outputs range from 50 to 2000 watts, with only 2 ampere-turns required for control of the smallest units.

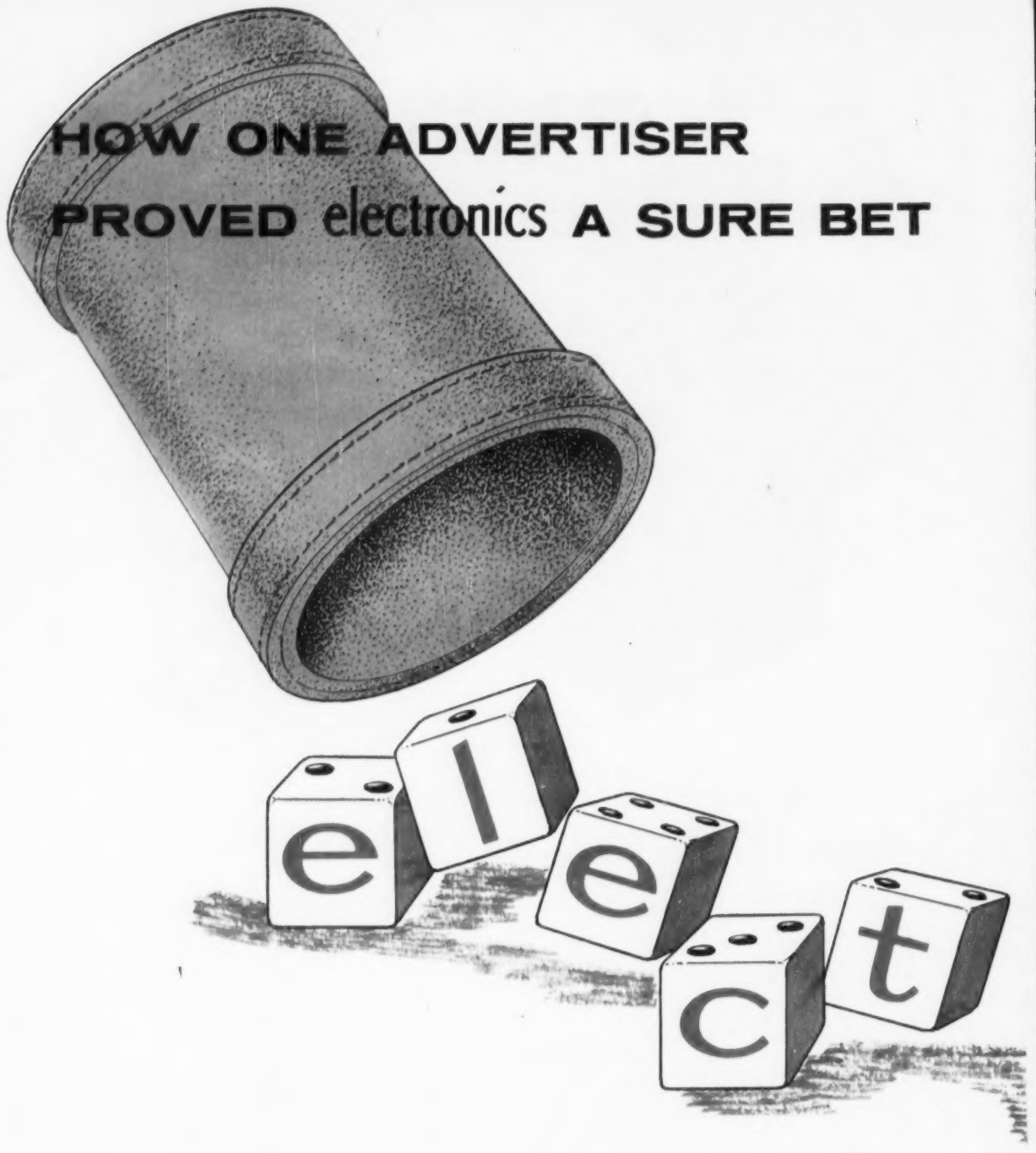
In addition to higher gain, smaller exciting current, and fewer ampere-turn characteristics, CONTROL reactors have a 40 to 1 cut-off ratio. They are totally enclosed so that the high performance toroidal cores used are protected, and the entire assembly has the ruggedness required for long life.

CONTROL offers the same convenience of standardization in use of high permeability magnetic devices that you've enjoyed with other components. Add to this convenience ruggedness and freedom from maintenance which is unmatched, and you'll welcome CONTROL to your design picture. Write for complete details and literature today. *CONTROL, Dept. E-36, Butler, Pennsylvania.*

Reliability begins with CONTROL

A DIVISION OF MAGNETICS, INC.

HOW ONE ADVERTISER PROVED electronics A SURE BET



"A regular schedule in the business editions as well as in the established technical edition"

ABC ABP

A McGRAW-HILL PUBLICATION . . . 330

AIRPAX
DESIGNERS PRODUCTS COMPANY ENGINEERS

MEMO TO: Sales Representatives

From : Frank H. Rockett

Subject: Current Advertising

November 26, 1956

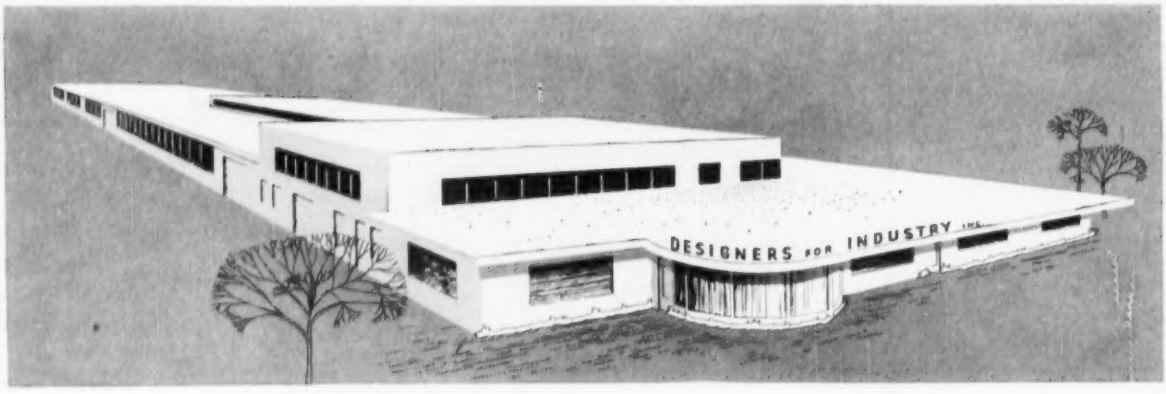
This (the geographic distribution of inquiries from electronics*) indicates that the quality of inquiries from electronics, because they come proportionally from all market centers, is high. The tabular results also show that the circulation of electronics reaches as representative a cross section of the electronic market as do the other magazines combined. For this reason, we will continue to use electronics as the main stay of our advertising in 1957. This will include a regular schedule in the new business editions as well as in the established technical editions.

*These conclusions of Mr. Rockett, Advertising Director for Airpax Products Company, result from an analysis of inquiries from advertisements and press releases over an 18-month period (January, 1955 through June, 1956).

W E S T 4 2 N D S T R E E T . . . N E W Y O R K 3 6 , N . Y .

SYSTEMS ENGINEERS and SCIENTISTS experienced in

RADAR • COUNTER MEASURES • MISSILE GUIDANCE • DATA REDUCTION
AIR DEFENSE • COMMUNICATIONS • UNDERWATER ORDNANCE
CHECKOUT AND GROUND SUPPORT



DFI's modern headquarters for engineering research and development.

Electronic and Mechanical Personnel

For trained, experienced men (advanced degree preferred) with creative ability, Designers for Industry offers challenging work and an unusual opportunity.

We are looking for those who have grown into the systems field via the equipment research and development road — and who have the ability to conceive completely new approaches to highly difficult problems . . . *men who can spearhead major technical break-throughs* . . . and who can coordinate all phases of project effort.

In return we offer permanent career opportunities at DFI where:

You will work in an independent research and development organization incorporated in 1935 and showing a history of steady growth serving both military and commercial clients

the employees own the corporation (over 100 senior employee-stockholders)

a pension trust and a merit bonus return 62½% of all profits to the employees in a combination of annuities, cash and stock

the "fringe" benefits include such things as a very liberal paid vacation schedule and an educational refund plan. Leading educational centers nearby

professional freedom, mutual trust, challenging work and a dynamic, growing organization are combined into the proper atmosphere for stimulating creative development.

If you are interested write to James E. Burnett, Vice President, giving pertinent professional information. All information will be treated in complete confidence.

PLANNED DFI PRODUCTS

Designers for Industry
Incorporated 1935

4241 Fulton Parkway • Cleveland 9, Ohio

Sperry radar test set rides early warning picket ships

AN/UPM-44B unit checks S-band radar in flight

Checking the performance of search radar aboard Navy WV-2 and Air Force RC-121D radar planes is the job of the Sperry AN/UPM-44B combination test set. While these Lockheed Super Constellations patrol both coasts 24 hours a day, their radars are constantly monitored by AN/UPM-44B test equipment to assure peak efficiency at all times.

Developed by Sperry in cooperation with the Navy's Bureau of Aeronautics to meet all requirements of MIL-T-945A, this new S-band test set combines in a single unit the multiple functions of a frequency meter, power meter, signal generator, spectrum analyzer and synchroscope.

Compact and portable, the AN/UPM-44B provides direct reading of peak or average transmitted power and frequency. It instantly detects any deterioration in performance, and pinpoints the source of trouble for crewmen to take corrective action. Sensitivity, stability and bandwidth measurements are made with pulse or frequency modulated signals produced by the test set. A gating circuit permits spectrum analysis of any selected pulse from a multi-pulse system.

Write our Microwave Electronics Division for additional information covering test sets in the frequency range of 400 mc through 40,000 mc.

MICROWAVE ELECTRONICS DIVISION

SPERRY GYROSCOPE COMPANY

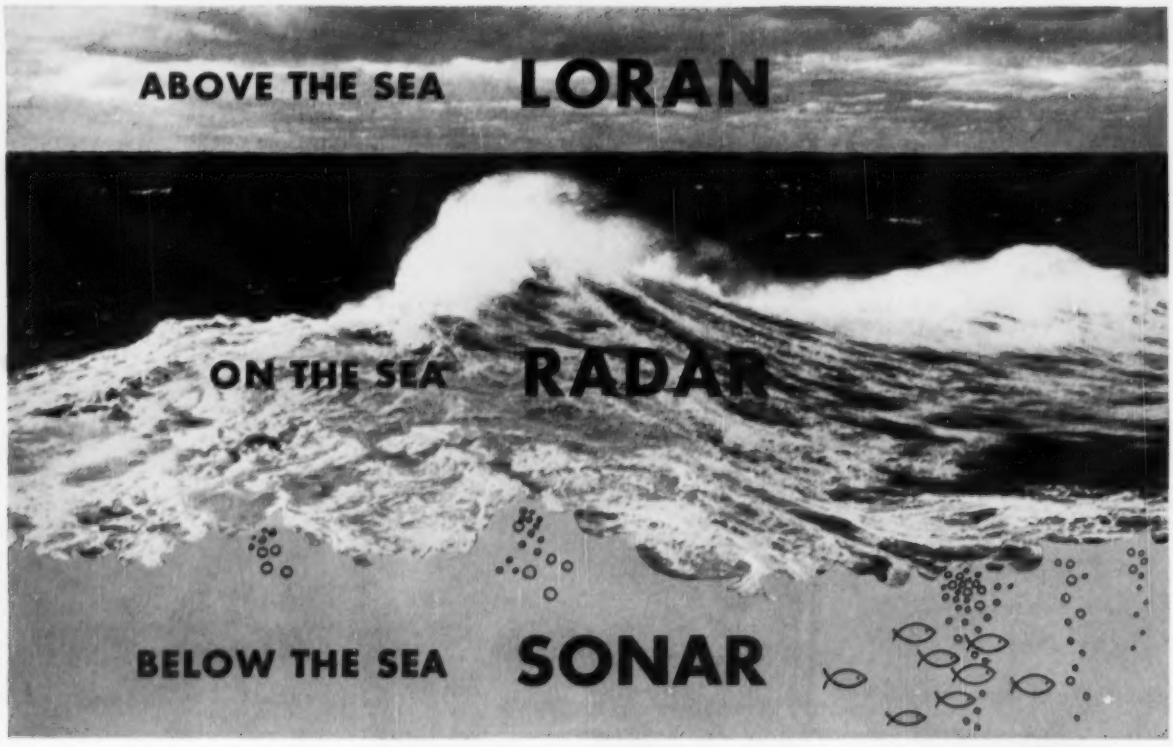
Great Neck, New York

DIVISION OF SPERRY RAND CORPORATION

BROOKLYN • CLEVELAND • NEW ORLEANS • LOS ANGELES • SEATTLE • SAN FRANCISCO

IN CANADA: SPERRY GYROSCOPE COMPANY OF CANADA, LIMITED, MONTREAL, QUEBEC

Want more information? Use post card on last page.



HIGH-PERFORMANCE EQUIPMENT BY Edo

SONAR, RADAR, LORAN and other related equipment designed and built by Edo serves commerce and national defense below the sea, on the sea, above the sea.

- Newly introduced Edo airborne LORAN puts this over-ocean navigation aid in the pilot's cockpit, so compact is its design, so simple its direct-reading capability.
- Edo RADAR, with close-in definition heretofore unheard of, provides safe, accurate navigation in the thickest weather for vessels, large and small, in open sea or the narrow confines of river, harbor or channel.
- Edo SONAR—active or passive—is in production for a wide range of commercial and naval applications from fish finding to long range submarine detection.

Whether it involves equipment for use below the sea, on the sea or above the sea, Edo's unique 33 years of work in aerodynamics, hydrodynamics and electronics gives the company a unique background of experience that is reflected in the superior performance of equipment bearing Edo's famed flying fish emblem.

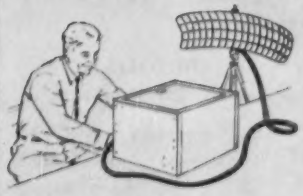
Edo **CORPORATION** College Point, L.I., N.Y. SINCE 1925

MAXIMUM BROADBAND MICROWAVE POWER

650 to 10,750 mc

for standing wave determinations

Fast Uni-Dial operation saves engineering manhours in the laboratory.



for antenna and transmission loss measurements

Assured full power output throughout range.

for testing microwave components on the production line

±1% frequency accuracy.

microwave signal sources

When you need power — and frequency accuracy — Polarad Microwave Signal Sources provide a maximum power output 10 to 20 db greater than comparable signal generators. They are excellent for standing wave determinations, antenna and transmission loss measurements, and testing microwave components on the production line.

These units are direct reading and continuously tuned with Polarad's UNI-DIAL control that automatically tracks the reflector voltage as the klystron cavity is being tuned. There are no slide rule interpolations, no mode charts needed. The frequency range of these signal sources is approximately 2:1 except for the X band unit. Maximum power output is assured throughout the entire range of each instrument by means of a power set control. For improved stability a temperature compensated klystron tube is utilized in an external precision cavity. All Polarad Signal Sources can be externally modulated with either square wave or FM signals.

Polarad Model KX Klystron Power Supply is especially designed to work with all 5 Models of the Polarad Signal Sources. Has special 1,000 cps square wave output for modulating purposes. Available on the Equipment Lease Plan. Contact the Polarad representative in your locality for complete information.

MINIMUM POWER AVAILABLE FROM POLARAD SIGNAL SOURCES IN THE RANGE OF 650 TO 10,750 MC

FREQUENCY RANGE		MODEL SSR 650-1300MC	MODEL SSL 1050-2250MC	MODEL SSS 2140-4600MC	MODEL SSM 4450-8000MC	MODEL SSX 7850-10,750MC	MODEL SSXA 7850-11,500MC
MINIMUM POWER AVAILABLE (mw)	LOW RANGE	100	80	50	15	13	Available on Special Order
	MIDDLE RANGE	400	150	100	45	35	
	HIGH RANGE	400	150	60	15	20	

A complete line of Extremely High Frequency Microwave Signal Sources also available in a range of 12.4 to 50.0 KMC

Maintenance Available by Field Service Specialists

POLARAD ELECTRONICS CORPORATION

43-20 34th Street, Long Island City 1, N. Y.

REPRESENTATIVES: Albany, Atlanta, Baltimore, Boston, Chicago, Cleveland, Dayton, Denver, Englewood, Fort Worth, Kansas City, Los Angeles, New York, Philadelphia, Portland, Rochester, St. Louis, San Francisco, Schenectady, Stamford, Syracuse, Washington, D. C., Winston-Salem, Canada: Arnprior, Ontario.
Resident Representatives in Principal Foreign Cities

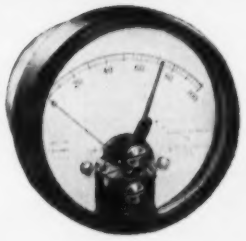
Want more information? Use post card on last page.

METER-RELAYS: Construction and Operation

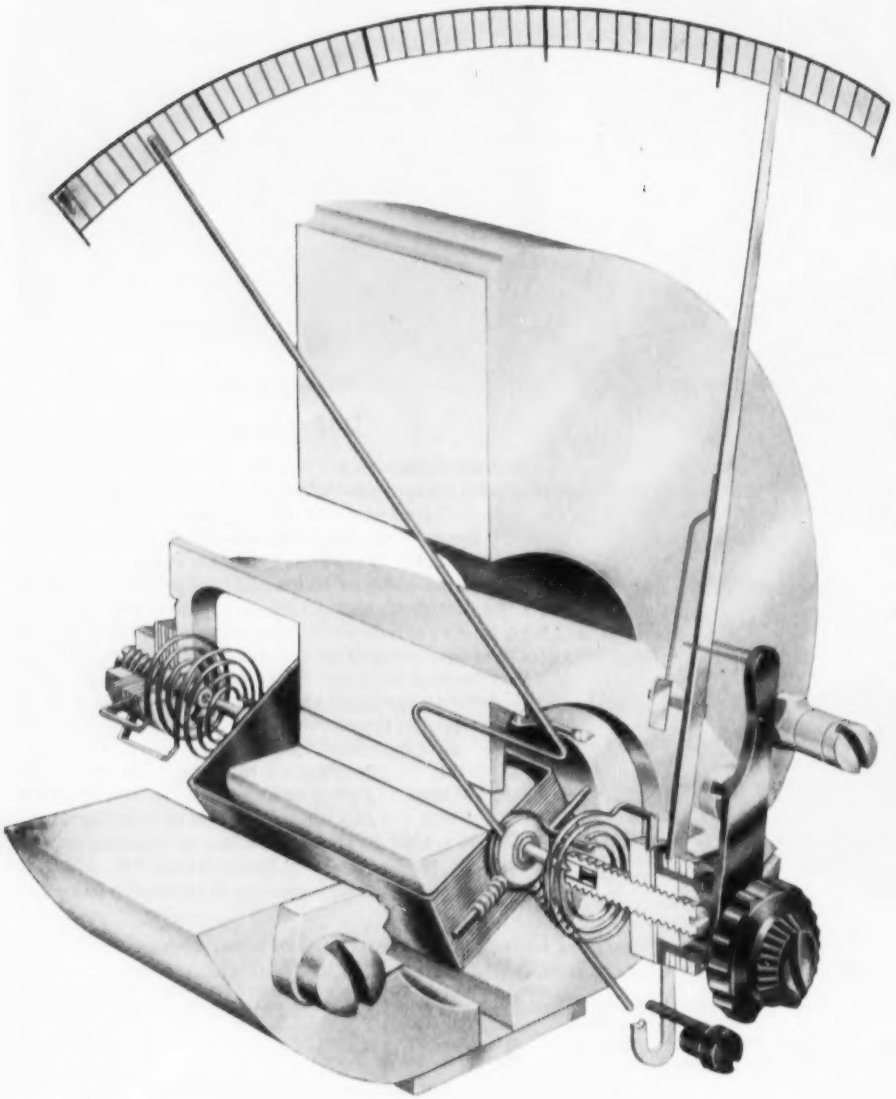
Adjustable pointer with plate contact, foreground, is mounted in bracket. Moving pointer, with contact, is part of conventional D'Arsonval-type meter movement. The moving coil and pointer assembly is pivoted in cushioned jewels, and rotates in the flux of a permanent magnet. The coil is connected to hairsprings.

Since the torque of the moving coil is too low for reliable contact operation, locking coil (wound on the moving coil) develops additional torque to close contacts with 1 to 3 grams pressure. Reset can be manual or automatic. It consists of opening the locking circuit. Built-in spring action kicks contacts apart forcibly. Meter-relays can be built with two adjustable pointers for high-low control.

Write for 40-page Catalog 4B for circuitry, specifications and prices.



Model 255-C
Single Contact, High Limit
0-100 Microamperes, D.C.
Price $46.00



AUTOMATIC CONTROL

Control action is initiated when the indicating pointer makes contact with the adjustable pointer. Many different functions or conditions, such as pressure, heat, speed, radiation, current, voltage, etc. can be controlled with better than 2% accuracy. Prices range from $30 to $110. Used in atomic installations, radar warning (DEW LINE), and hundreds of industrial applications. Ranges from 0-5 Microamperes to 0-50 Amperes; 0-5 Millivolts to 0-500 Volts; −400 to + 3000° F.

ASSEMBLY PRODUCTS, INC. Mail Address: Chesterland 4, Ohio

Wilson Mills Road
Chesterland 4, Ohio
Telephone (Cleveland, Ohio)
HAmilton 3-4436

•

69-873 Dillon Road
P.O. Box 308
Desert Hot Springs 4, Cal.
Telephone 4-3133 or 4-2453

Booth 1323, DESIGN ENGINEERING SHOW, May 20-23, Coliseum, New York City

MIL-AC Custom Air Conditioning

Condition: Military Mobility

Mobile electronic systems can function under the most difficult environmental conditions (MIL-E-5272*), by using highly specialized mobile air conditioning equipment.

Custom air conditioning is our business at Ellis and Watts. For example, we recently designed and built MIL-AC air conditioning equipment for trailer-mounted F-11-F operational flight trainer simulators. They develop 10 tons of cooling capacity at 130° F., using no water. These units are only 24" wide and can be mounted anywhere to suit specific space requirements. This equipment is designed for an unusual 3-zone air distribution system to maintain constant temperature and humidity in computer, instructor and trainee sections — each with a different varying load condition.

MIL-AC units are self-contained, compact, lightweight, readily air transportable. They can be designed to cool, heat, humidify, dehumidify, filter, and can incorporate air-cooled or water-cooled condensers. Units are manually or automatically controlled. We are staffed with specialists who will analyze your requirements, submit a proposal, complete your installation promptly and to your complete satisfaction.

Write for helpful load calculating Nomograph and other technical data for use in making time-saving preliminary calculations.

*Military specification dealing with the following climatic and environmental conditions: Temperature, humidity, altitude, salt spray, vibration, fungus, sunshine, rain, sand and dust, explosive atmosphere, acceleration and shock.

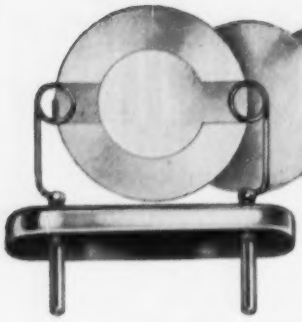
Typical MIL-AC Unit. MIL-AC configurations, features and functions to suit your specific requirements.

ELLIS AND WATTS PRODUCTS, INC.

P.O. Box 33, Cincinnati 36, Ohio.

Ellis and Watts also design and build custom air conditioners, liquid coolers and heaters, dehumidifiers, wave guide dehumidifiers, laboratory temperature and humidity control units.

Want more information? Use post card on last page.



MILLIONS of crystals made to ANY specifications but only ONE standard quality

Midland frequency control units are on the job in two-way communications on land, sea and in the air throughout the world. Now they're playing a leading role in color television. The range of applications Midland serves is wide, but every Midland crystal has one thing in common: a single level of quality.

That one quality is simply the highest that modern methods and machines can produce. It's assured by Midland's system of critical quality control—exacting inspection and test procedures through every step of processing.

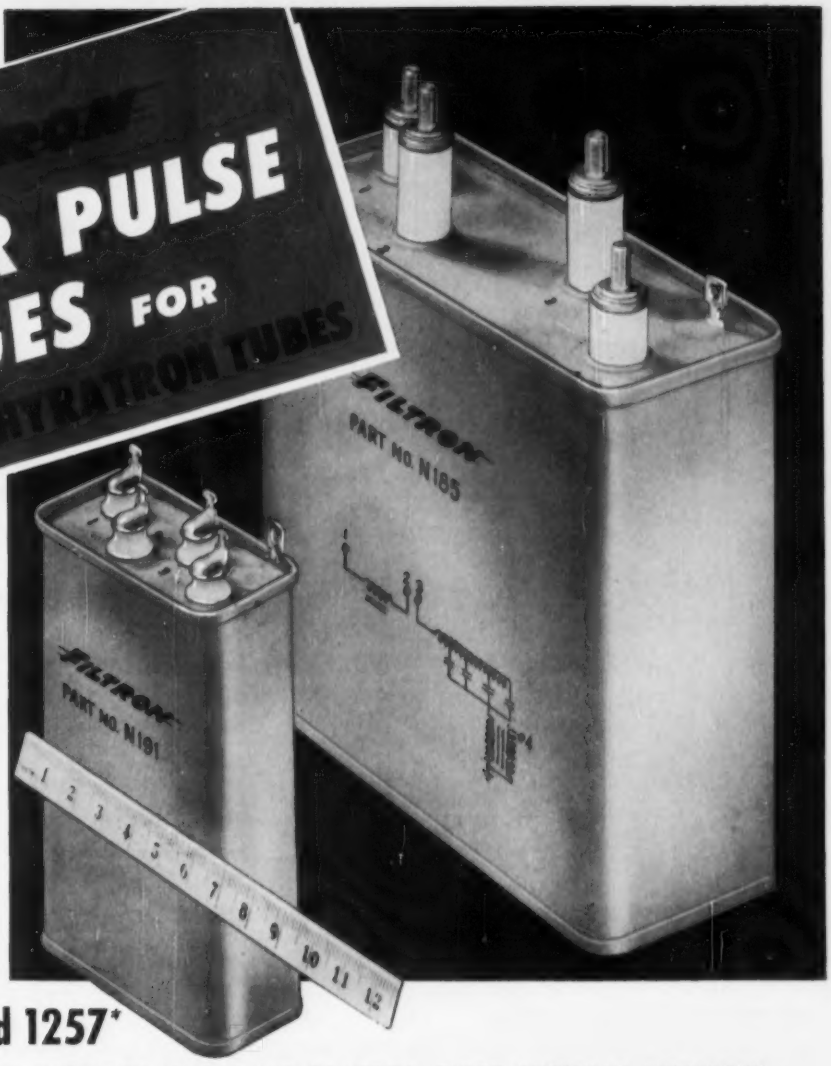
Result: Your Midland crystal is going to give you the best possible service in frequency control—with stability, accuracy, and uniformity you can stake your life on . . . as our men in the armed forces and law enforcement do every day.

Whatever your Crystal need, conventional or highly specialized. When it has to be exactly right, contact

Midland
MANUFACTURING COMPANY, INC.
3155 Fiberglas Road, Kansas City, Kansas

WORLD'S LARGEST PRODUCER OF QUARTZ CRYSTALS

FILTRON TRIGGER PULSE PACKAGES FOR HYDROGEN THYRATRON TUBES



Trigger pulses according to latest MIL-E-1 spec for Hydrogen Thyratrons 5949/1907, 5948/1754 and 1257*

EACH PULSE PACKAGE INCLUDES CHARGING REACTOR, PULSE FORMING NETWORK AND PULSE TRANSFORMER SPECIFICALLY DESIGNED FOR THIS APPLICATION.

FILTRON TRIGGER PULSE PACKAGE N-191
For 5949/1907 and 5948/1754 thyratrons

Size: 1 3/16" x 2 1/2" x 4 1/4" high (4 3/4" overall)
Input: 550 VDC @ 26 MA max.
Output (thyratron grid disconnected)
Pulse Width: 2 μsec min at 70% amplitude
Amplitude: 1000 V peak positive
Rise Time: 0.35 μsec max. 26-70%
Impedance: 70 ohm nominal
Repetition Rate: 0-1500 pps

FILTRON TRIGGER PULSE PACKAGE N-185
For 1257 thyratron

Size: 2 1/4" x 5 3/4" x 5 1/2" high (7" overall)
Input: 4 KVDC @ 82 MA max.
Output: (thyratron grid disconnected)
Pulse Width: 2 μsec min. at 70% amplitude
Amplitude: 2500V peak positive
Impedance: 15 ohm nominal
Repetition Rate: 0-1250 pps

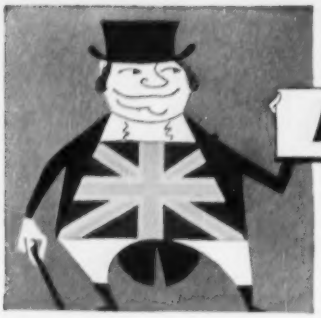
*There is no MIL specification for the 1257 type thyratron, but the pulse package characteristics conform to the latest extant specifications for this tube.

Canadian Representative: Aircraft Appliances & Equipment Ltd., 585 Dixon Side Road, Toronto 15, Ont., Canada

FILTRON CO., INC., FLUSHING, LONG ISLAND, NEW YORK
PLANTS IN FLUSHING, NEW YORK, AND CULVER CITY, CALIFORNIA

RF INTERFERENCE FILTERS • FIXED CAPACITORS • PULSE NETWORKS • DELAY LINES

Want more information? Use post card on last page.



ELECTRONICS IN BRITAIN

The British Electronics Industry is making giant strides with new developments in a variety of fields. Mullard tubes are an important contribution to this progress

The expert choice . . . . . for medium power, high fidelity equipment

EL84

Principal Ratings

Heater	6.3V, 0.76A
Max. plate voltage	300V
Max. plate dissipation	12W
Max. screen voltage	300V
Max. screen dissipation (max. signal)	4W
Max. cathode current	65mA

Base

Small button noval 9-pin

British high fidelity experts know that for medium powered equipment there is no finer tube than the EL84. A pair of these tubes provide a power output of 10W at a distortion level of less than 1% while their transconductance value of 11,300 μmhos results in exceptional sensitivity. The EL84 may also be used for higher powers. For example, two tubes in push-pull will provide outputs of up to 17W at an overall distortion of 4%.

A single EL84 has a maximum plate dissipation of 12W. It provides an output of 5-6W for an input signal of less than 5V r.m.s. at plate and screen voltages of 250V.

Supplies of the EL84 for replacement in British equipments are available from the companies listed.

Supplies available from:—

In the U.S.A.

International Electronics Corporation, Dept., E5, 81 Spring Street, N.Y. 12, New York, U.S.A

In Canada

Rogers Majestic Electronics Limited, Dept. IE., 11-19 Brentcliffe Road, Toronto 17, Ontario, Canada.

Mullard

ELECTRONIC TUBES

used throughout the world

MULLARD OVERSEAS LTD., MULLARD HOUSE, TORRINGTON PLACE, LONDON, ENGLAND

Mullard is the Trade Mark of Mullard Ltd., and is registered in most of the principal countries of the world.

MEV 43

Can you use the talent that built 1,500 Y-4 bombsights on schedule?

These General Mills technicians are representative of the production talent that built more than 1,500 Y-4 bombsights, 1,500 coordinate converters, 1,400 azimuth and sighting angle indicators and 1,400 amplifier and power supply units—and, delivered them to the Air Force *on time*. Here the men inspect a bombsight before it progresses to the next stage of production.

Because we have the highly skilled men—and the men have the specialized tools and machines—we produce precision piece parts or complete, complex assemblies to meet the most exacting requirements.

While building the Y-4 bombsight, we improved original design, exceeded USAF specifications. In addition, our thorough testing facilities assured delivery of only perfect instruments.

Such performance has come to be expected of us and has benefited many other customers. We'd like to help with your production problems too.

Booklet Tells More, explains mechanical and electro-mechanical production facilities. Send to Dept. EL-5, Mechanical Division, General Mills, 1620 Central Ave. N.E., Minneapolis, Minn.

No slow-downs for the B-47—Bombsights ready in advance! During production of the B-47 Stratojet, not a one was kept from the ready-line for lack of a bombsight. The same developmental, engineering and production skills that gave the Air Force on-time delivery are available to speed production of your products.

MECHANICAL DIVISION

General Mills

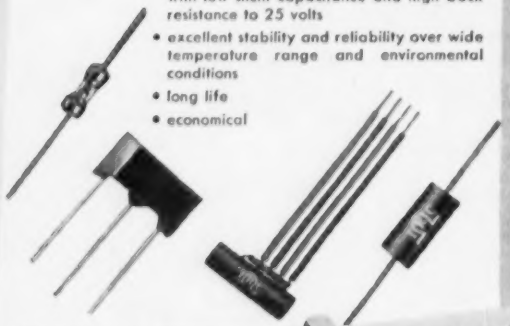
CREATIVE RESEARCH AND DEVELOPMENT + PRECISION ENGINEERING AND PRODUCTION

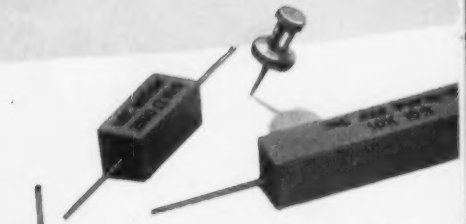
6 NEW ANSWERS TO TODAY'S

New IRC Dual Diodes

New answer to the bulk, higher cost, and assembly problems of vacuum tube diodes in low current applications.

- featuring balanced miniature selenium cells with low shunt capacitance and high back resistance to 25 volts
- excellent stability and reliability over wide temperature range and environmental conditions
- long life
- economical

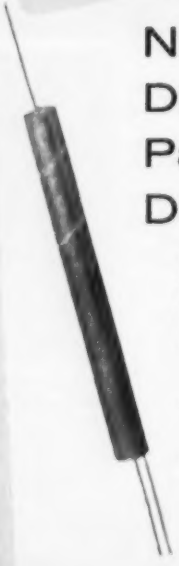




Expanded line of axial lead resistors offering wider ranges, higher operating temperatures and easier assembly at lower cost.

- now available in 5, 7 and 10 watt ratings
- leads automatically secured to element for maximum terminal security
- sturdy rectangular ceramic case with special IRC insulating cement

Power Resistor Line



New IRC Distributed Parameter Delay Lines

A compact, more uniform product for time delays of less than 1.0 microsecond at impedance levels of 4000 ohms or less.

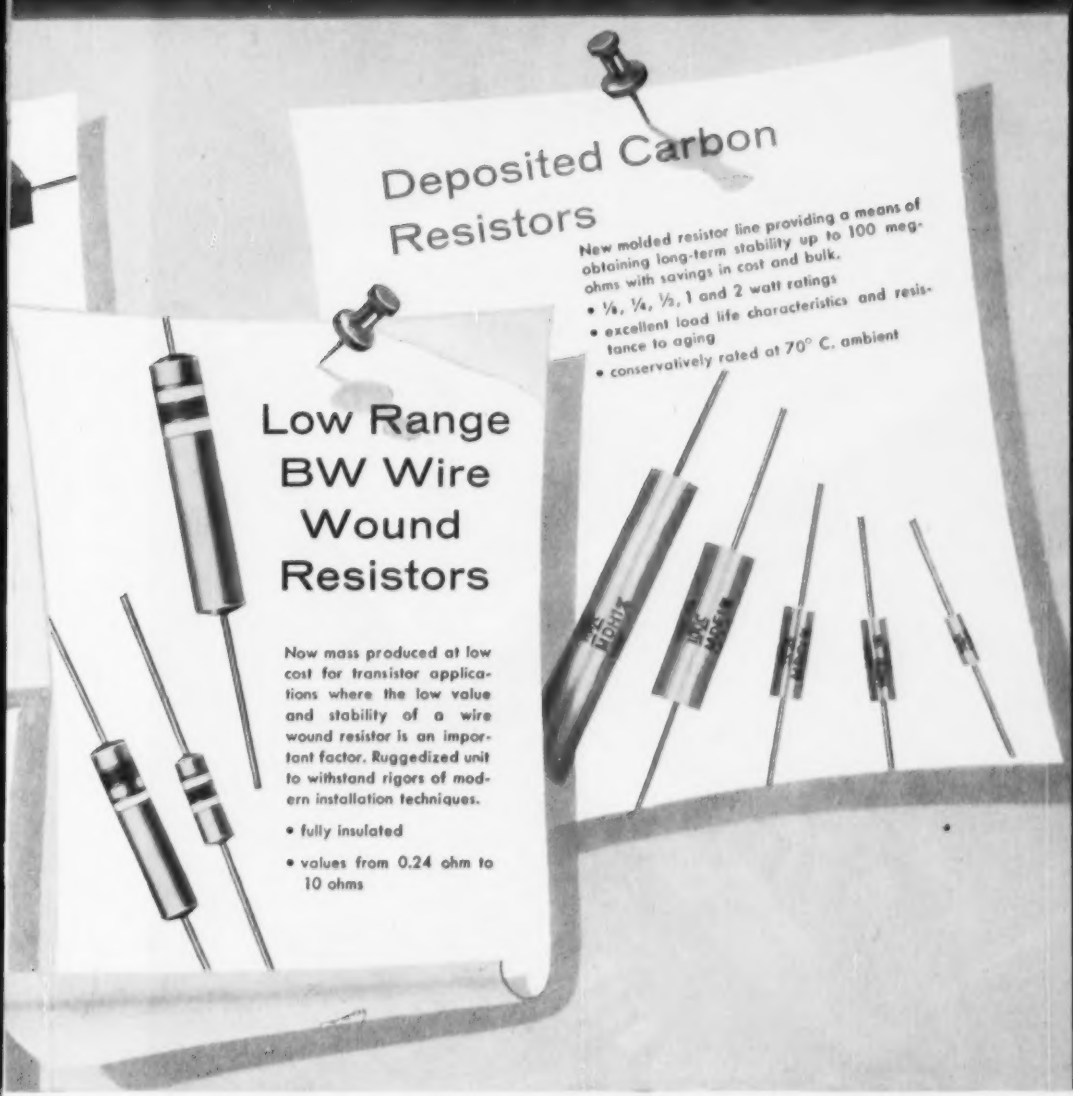
- designed for mass production in a continuous process
- featuring high stability and uniform characteristics
- economical

New IRC Hermetic Sealing Terminals

Superior hermetic sealing and insulating performance in miniature units meeting a wide variety of space, electrical, and termination requirements.

- four body designs and six lead types
- excellent resistance to thermal shock, zero water absorption, physically tough, will not crack or craze.
- special fluorocarbon plastic body with superior electrical and mechanical characteristics

DESIGN AND COST PROBLEMS


Deposited Carbon Resistors
New molded resistor line providing a means of obtaining long-term stability up to 100 megohms with savings in cost and bulk.
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• excellent load life characteristics and resistance to aging
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Low Range BW Wire Wound Resistors
Now mass produced at low cost for transistor applications where the low value and stability of a wire wound resistor is an important factor. Ruggedized unit to withstand rigors of modern installation techniques.
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INTERNATIONAL RESISTANCE COMPANY

Dept. 233, 401 N. Broad St., Philadelphia 8, Pa.
In Canada: International Resistance Co., Ltd., Toronto, Licensee

Send complete information on ☐ Selenium Dual Diodes, ☐ Delay Lines, ☐ Hermetic Sealing Terminals, ☐ Power Resistors, ☐ Molded Deposited Carbon Resistors, ☐ BW Wire Wound Resistors

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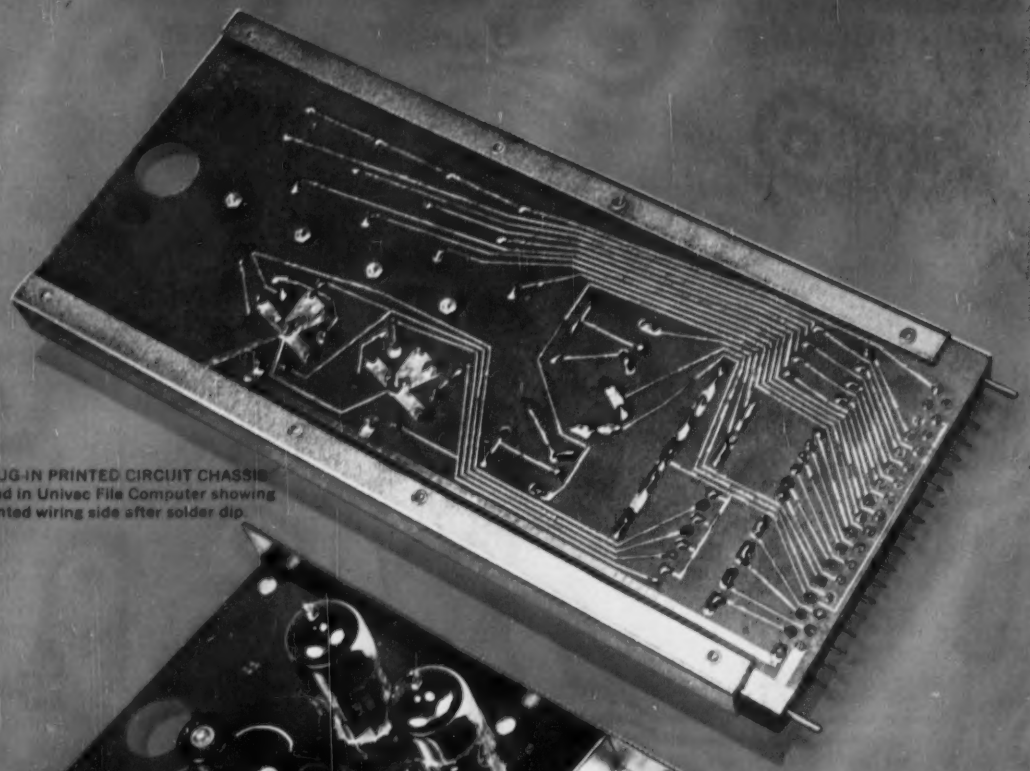
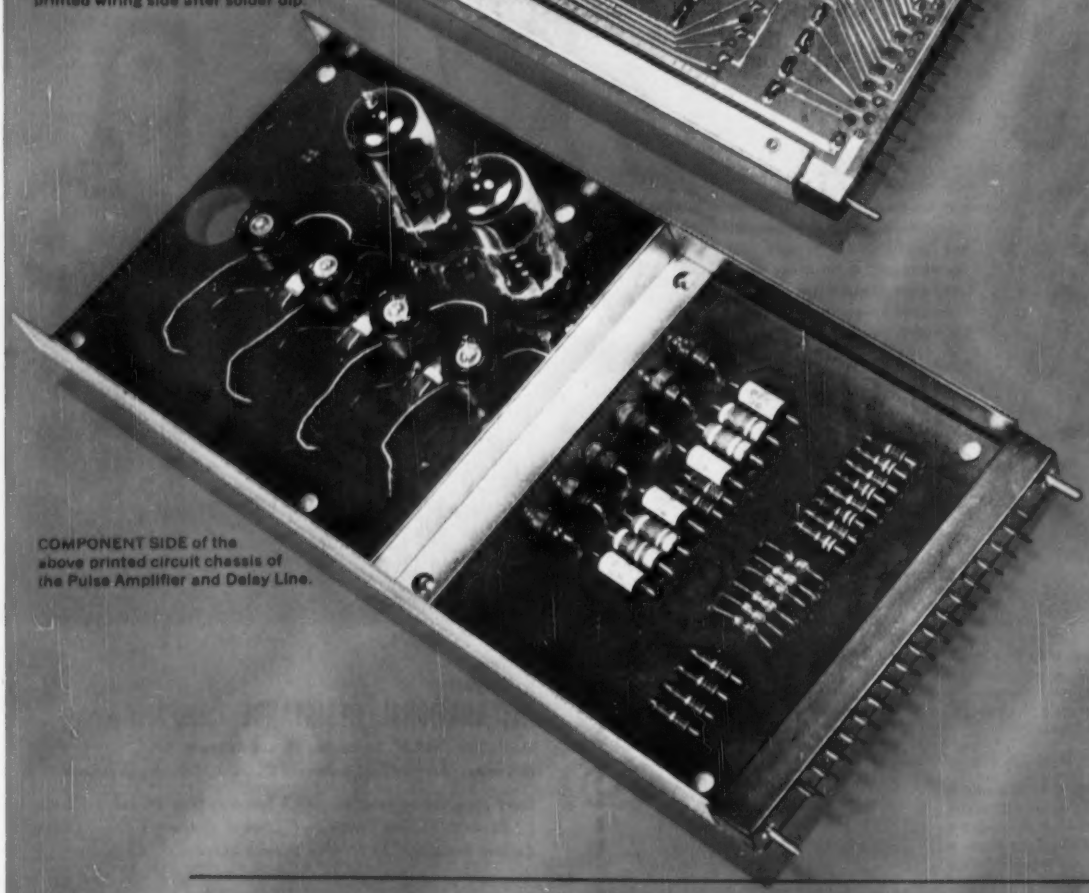
"HIGHLY DEPENDABLE,"



PLUG-IN PRINTED CIRCUIT CHASSIS used in Univac File Computer showing printed wiring side after solder dip.



COMPONENT SIDE of the above printed circuit chassis of the Pulse Amplifier and Delay Line.

says Remington Rand Univac*

of the

REVERE ROLLED COPPER

used in its Printed Circuits

A leader in the manufacture of digital computing systems, Remington Rand Univac utilizes the latest manufacturing techniques because computing systems require printed circuit boards completely free of defects.

In examining copper-clad laminated boards made with Revere rolled copper Remington Rand Univac said, "We found even the finest lines were freer from pits, pinholes and other imperfections. In addition, there were no detectable lead inclusions. Also, the rolled copper thickness is uniform. We get what we specify."

Designed and developed by Remington Rand Univac, digital computers use hundreds of printed circuits. Each one must operate according to specifications at all times. There can be no sacrifice of conductivity. Because of more uniform etching qualities Revere Rolled Copper is capable of producing better edge definition, allowing closer spacing of lines. A uniform solder coat under normal or automatic soldering operations is possible because the copper is free from surface defects. Fluxes wet readily because of this clean surface. These factors combine to make Revere Rolled Copper the ideal medium for these printed circuit boards.

And they are the very reasons why you should insist that Revere Rolled Copper be specified by you when ordering blanks from your laminator.

It is available in unlimited quantities in standard coils of 350 lbs. in widths up to 38" and in .0014, .0028, and .0042 gauges, weighing approximately 1 oz., 2 oz. and 3 oz. per square foot; or heavier if required. Many users have found that because of its unique characteristics 1 oz. Revere Rolled Copper can be used instead of the 2 oz. required when other kinds of copper are used, thus effecting still greater savings in material cost. Revere Rolled Copper exceeds requirements of standard specifications and meets ASTM B5 specifications for purity with 99.9% minimum.

Consult your laminator regarding the use of Revere Rolled Copper for your printed circuits, or contact the Revere Representative nearest you through the yellow pages of your local telephone directory.

Revere does no laminating of printed circuit boards, making only rolled copper. Revere Rolled Copper can also be furnished rolled down to .0006 for coil winding applications.

*Reg. U. S. Pat. Office

UNIVAC FILE COMPUTER

REVERE COPPER AND BRASS INCORPORATED

Founded by Paul Revere in 1801

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Mills: Rome, N. Y., Baltimore, Md.; Chicago, Clinton and Joliet, Ill.; Detroit, Mich.; Los Angeles and Riverside, Calif.; New Bedford, Mass.; Brooklyn, N. Y.; Newport, Ark.; Ft. Calhoun, Neb. Sales Offices in Principal Cities, Distributors Everywhere.

CTC family of kollet knobs makes set screws unnecessary — unique locking device gives them firmer holding power under vibration and continued use. Circumferential pressure on shaft eliminates scoring or marring. Tremendous holding power whether on shafts of soft brass, aluminum or stainless steel. Kollet knobs left to right for $\frac{1}{8}$" shaft, $\frac{1}{8}$" or $\frac{1}{4}$" and $\frac{1}{8}$" or $\frac{1}{4}$".

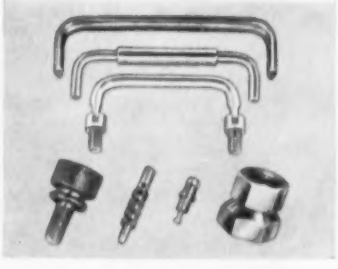
Three who'll dress to please you

CTC's family of kollet knobs is carefully made of prime materials, as are all CTC components. And they have this added feature, being in the open as they are: They're good-looking and adaptable.

Made of molded Tenite II in matte finish their metal face plates snap into place, completing the design and covering the kollet locking device. You have a choice of ten color inserts for instrument panel coding, and can have the knobs with or without skirts or indicating lines.

Reliability is the key characteristic of every component CTC makes. Every component is unconditionally guaranteed in quantities from one to millions. Other CTC components include coil forms, coils, terminal boards, terminals, diode clips, insulated terminals and hardware.

For sample specifications and prices, write now to Sales Engineering Dept., Cambridge Thermionic Corporation, 437 Concord Ave., Cambridge 38, Mass. West Coast stocks maintained by E. V. Roberts Associates, Inc., 5068 West Washington Blvd., Los Angeles 16, and 61 Renato Court, Redwood City, California.



CTC Panel Hardware meets or betters government specifications. Typical quality hardware shown: oval handle, adjustable handle, folding handle, thumb screw, plug and jack, shaft lock. Other quality hardware includes battery clips, terminal boards, diode clips, dial locks. Variety of finishes available.

CTC

CAMBRIDGE THERMIONIC CORPORATION

makers of guaranteed electronic components
custom or standard

Square *RE-USABLE* Metal *Pad-Kaging* Containers

ELIMINATE majority of handling and storage problems

REDUCE shipping weights and cubic footage

These RE-USABLE Metal Pad-Kaging Containers were developed by PETERS-DALTON for the U. S. Armed Forces. They have been approved and are in use for shipping and storing innumerable items.

P-D Containers eliminate the storing of many cumbersome and highly inflammable materials—they also eliminate the excess labor usually required in packaging such items as delicate radar instruments. Older methods caused finished packages to be heavy and bulky. They were susceptible to breakage and penetration to moisture and fungus. They were wasteful because of their excessive use of man-hours and materials, culminated by the eventual scrapping of the expensive packaging. Also, when reshipping was required, old fashioned containers after having once been opened, were seldom satisfactory for adequate repackaging of the materials — endangering them to damage while in transit. These inadequacies and limitations have been virtually eliminated through P-D RE-USABLE Metal Shipping Containers.

* * *

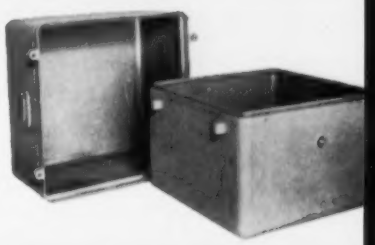
Features include: Lightness: Completed packs weigh far less than older style types. Compactness: The P-D RE-USABLE Metal Containers frequently save more than 50% of cubic footage. Economy: Material and man-hour outlays for packaging are reduced 25%.

Special Features: Containers are equipped with air fill valves to eliminate dangers of fungus or moisture and dial type humidity indicators. Drop handles furnished for containers weighing less than 200 lbs.—heavier containers have been designed for fork truck lifting. Extremely simple to close, only ordinary bolts (4 on the smallest container to 14 on the largest) are required; the simplest of hand tools perform the closing or opening operations. Optional: Pressure relief valves to equalize inside to outside pressures.

* * *

These RE-USABLE Metal Containers were manufactured by PETERS-DALTON for items ranging from aircraft engines, electronic parts, to large A-N containers in all types and sizes for shipping purposes. Complete engineering and manufacturing facilities are at your disposal for design, testing and fabricating. We'll be glad to tell you more—just write, wire or phone.

Materials formerly used in packaging one light military electronic item.



Only two parts to handle.

P-D Re-Usable Container ready to be closed and sealed. Note the simplicity of design.

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for low voltage power supply...

SANGAMO
Type DCM
Electrolytic Capacitors

In computers, calculators, electronic controls, and related equipment—wherever *capacity stability with long life* is a must—count on Sangamo Type DCM Electrolytic Capacitors.

They minimize ripple voltage and insure steady, stable DC voltage. They save space by eliminating any need for heavy, bulky choke components with their substantial and often-varying load voltage drops.

Maximum Voltage Rating: 450 VDC

Sangamo DCM Electrolytic Capacitors provide exceptionally low equivalent series resistance . . . assure extremely high capacity for case size in low voltage ranges . . . and are specially designed to permit high ripple current without overheating. They can be supplied in maximum energy content rating of 80-watt seconds in voltage ratings from 15 to 450 VDC. Maximum capacity value of 33,000 mfds. can be supplied at 15 WVDC.

Write to-day for your file copy of Sangamo Engineering Bulletin TS-114.

Sangamo DCM Electrolytic Capacitors are housed in seamless, drawn aluminum containers with gasket-sealed molded alkyd resin base thermosetting plastic covers. Detail of cover construction insures minimum contact resistance in current carrying members and provides an adequate safety vent in case of heavy overload.

CAPACITY CHART

Rated Voltage DC	Surge Voltage	Max. Cap. in 2⅛ x 4⅝ Can	Max. Cap. in 2⅝ x 4½ Can	Max. Cap. in 3⅛ x 4½ Can
15	20	12,500	20,000	25,000
30	40	9,000	15,000	20,000
50	75	4,800	8,000	10,000
100	125	2,000	3,500	5,000
150	175	1,500	2,500	3,500
200	250	1,000	1,500	2,500
250	300	800	1,250	1,750
300	350	700	1,000	1,500
350	400	600	1,000	1,250
400	475	400	500	1,000
450	525	350	400	800

For additional capacity and voltage combinations, write us.

SANGAMO
Electric Company
Electronic Components Division
SPRINGFIELD, ILLINOIS

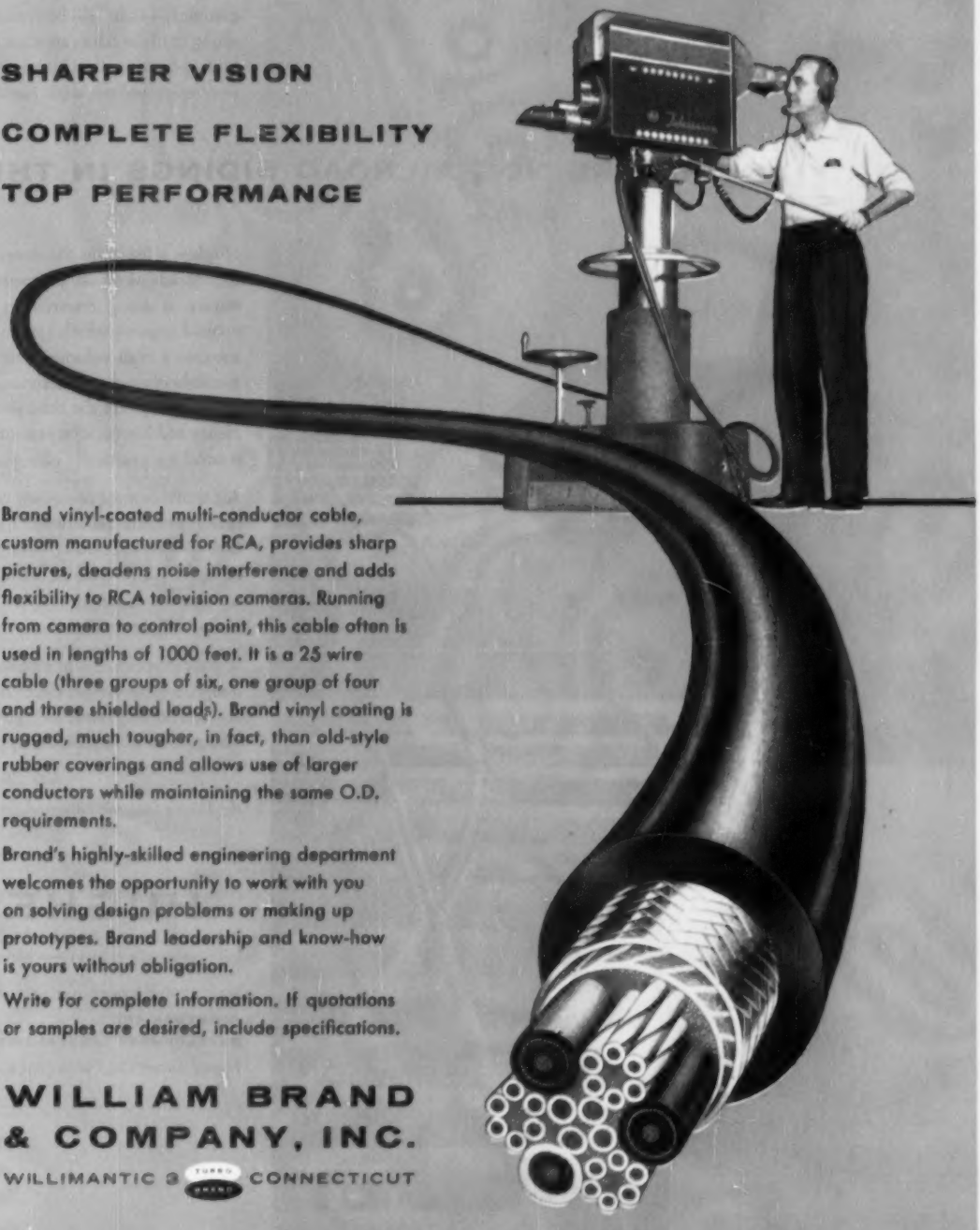
SC57-1

BRAND VINYL COVERED CABLE GIVES RCA TV CAMERAS

SHARPER VISION

COMPLETE FLEXIBILITY

TOP PERFORMANCE



Brand vinyl-coated multi-conductor cable, custom manufactured for RCA, provides sharp pictures, deadens noise interference and adds flexibility to RCA television cameras. Running from camera to control point, this cable often is used in lengths of 1000 feet. It is a 25 wire cable (three groups of six, one group of four and three shielded leads). Brand vinyl coating is rugged, much tougher, in fact, than old-style rubber coverings and allows use of larger conductors while maintaining the same O.D. requirements.

Brand's highly-skilled engineering department welcomes the opportunity to work with you on solving design problems or making up prototypes. Brand leadership and know-how is yours without obligation.

Write for complete information. If quotations or samples are desired, include specifications.

WILLIAM BRAND & COMPANY, INC.

WILLIMANTIC 3 CONNECTICUT

ELECTRICAL AND ELECTRONIC WIRES AND CABLES, HARNESSES AND CABLE ASSEMBLIES, PLASTIC AND COATED INSULATING FILMS, IDENTIFICATION MARKERS

When railroad traffic gets too heavy or complex, a train will be switched onto a siding until the tracks are clear. However, high-speed aircraft in busy traffic patterns over metropolitan areas cannot wait . . .

THERE ARE NO RAILROAD SIDINGS IN THE SKY

Hughes, a leader in the development of highly advanced data processing techniques, is doing research on air traffic control systems which can continuously monitor a high volume of air traffic and precisely control each individual airplane. With this system the time delays, inefficiency and inaccuracies present in manual control are practically eliminated.

Air traffic control represents only one of many projects underway. Confidential new projects . . . many infinitely more complex . . . promise an unlimited future to scientists and engineers in the Hughes Ground Systems Division.

If your experience is in electronic circuit design, logical design, electronic packaging, and radar systems, we invite you to investigate these outstanding opportunities.

the West's leader in advanced electronics

HUGHES

SCIENTIFIC STAFF RELATIONS
RESEARCH AND
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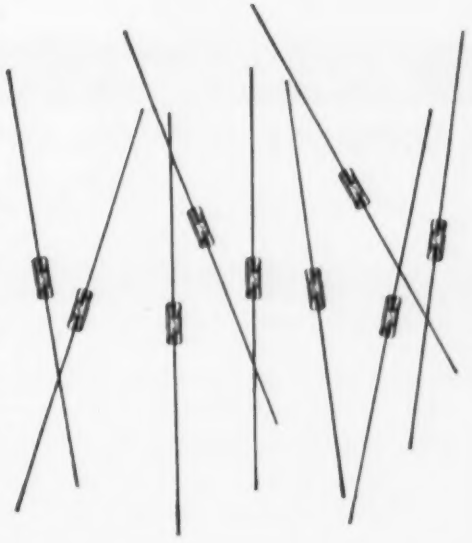
Hughes Aircraft Co., Culver City, California

HIGH CONDUCTANCE SILICON DIODES

Now, at Hughes, two new series



First, a high conductance series designed for operation up to 150°C and featuring forward conductance of at least 200mA at 1 volt, together with excellent reverse characteristics. Like all other Hughes diodes, these are packaged in our famous glass body for complete protection from contamination and moisture penetration. And like all other Hughes diodes, they conform to published specifications under a variety of operating conditions. Here, then, are specifications for representative types in the series.

	Max. DC Inverse Operating Voltage (volts)	Maximum Average Forward Current (mA) @25°C	Maximum Average Forward Current (mA) @150°C	Maximum Forward Voltage @200mA @25°C (volts)	Inverse Current At Specified DC Test Voltage (μa) 25°C	Inverse Current At Specified DC Test Voltage (μa) 150°C	Test Voltages (volts)
HD-6764	70	200	50	1.0	0.025	5	60
HD-6766	130	200	50	1.0	0.025	5	125
HD-6768	180	200	50	1.0	0.025	5	175
HD-6771	225	200	50	1.0	0.05	25	225
HD-6773	300	200	50	1.0	0.1	25	300
HD-6775	380	200	50	1.0	0.1	25	380

Second, a related high conductance series in the Hughes glass package with somewhat different characteristics.

	Comparable Competitive Types *	Max. DC Inverse Operating Voltage (volts)	Maximum Average Forward Current (mA) @25°C	Maximum Average Forward Current (mA) @150°C	Maximum Forward Voltage @100mA @25°C (volts)	Inverse Current At Specified DC Test Voltage (μa.) 25°C	Inverse Current At Specified DC Test Voltage (μa.) 150°C	Test Voltages (Volts)
HD-6132	1N482B	36	200	50	1.0	0.025	5	30
HD-6133	1N483B	70	200	50	1.0	0.025	5	60
HD-6134	1N484B	130	200	50	1.0	0.025	5	125
HD-6135	1N485B	180	200	50	1.0	0.025	5	175
HD-6136	1N486A	225	200	50	1.0	0.05	25	225

*Currently these competitive types are not registered with RETMA; hence their specifications are subject to change. When they are registered, diodes now designated as HD types will be supplied as 1N types according to the registered specifications.

For details, please write: SEMICONDUCTOR DIVISION • HUGHES PRODUCTS
International Airport Station, Los Angeles 45, California

HUGHES PRODUCTS

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HUGHES
SEMICONDUCTORS

EE's, ME's can you qualify

FILL OUT AND MAIL TODAY

Collins Radio Company *Confidential Application for Technical Employment*

LAST NAME	FIRST NAME	MIDDLE NAME	BIRTH DATE
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EMPLOYMENT RECORD

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PRESENT OR LAST EMPLOYER						
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STATE NATURE OF YOUR MOST RESPONSIBLE POSITION

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COLLEGE OR UNIVERSITY	MAJOR	DEGREE	GRADE PT. AV.

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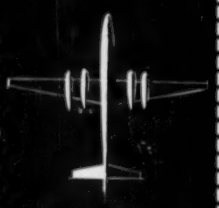
BRANCH OF SERVICE	RANK OR RATING	ACTIVE SERVICE ENTRY DATE	DISCHARGE DATE

Signature _____

COLLINS in Aviation

Collins completely outfits airline, military and business aircraft with the most advanced communication, navigation, flight control and instrumentation systems in aviation. Many new lightweight, reduced-size versions are now being delivered. Collins designed the original Integrated Flight System, leads in combining comm/nav/ident units into a single compact "CNI" package for new military aircraft, and continues to pace the industry in developments in airborne radar, ADF, ILS, VOR, HF and VHF communication.



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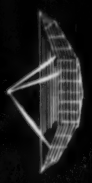
Collins engineers, designs and supplies the equipment, installs, and puts into operation integrated point-to-point communication systems of any scope. The Collins system engineering staff is backed by the finest equipment in the world, whether standard MF, HF or VHF, Transhorizon "scatter," microwave relay and multiplex or single sideband HF. Typical of Collins communication progress is "Kineplex" — a high speed data transmission system doubling communication capacity.



Send your application to:

L. R. Nuss
Collins Radio Co.
Cedar Rapids,
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✔*Command highest salary*

✔*Advance rapidly in a strong, growing company*

✔*Work with highest caliber development groups*

✔*Use the world's finest engineering facilities*

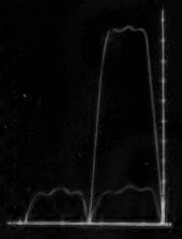
✔*Maintain Collins creative reputation*

Collins depends on its engineers. That's why you have to be good to earn a place on a Collins Research and Development team. Collins hard earned reputation was built on a solid foundation of engineering talent. The sales growth of the Company has justified Collins emphasis on engineering. Sales have increased 10 fold in the last 10 years. And employment of research and development personnel has more than kept pace. Collins growth will continue, and *you* can be a part of this growth.

Send the application form printed on the opposite page as an expression of your interest in knowing more about the opportunities at Collins. Your application will be held in the *strictest* confidence and will be answered immediately by a personal letter. Take only a few minutes now to fill out the application and mail to one of the addresses listed. This can be the turning point in your career.

COLLINS in Amateur Radio

In the early 1930's Collins set the standard in Amateur radio and, through continuous design and development, has raised this standard to its present single sideband station — the most honored and prized in the Amateur fraternity. This station is the top performing rig on the air with its kilowatt KWS-1 transmitter and highly selective 75A-4 receiver. Many of the leaders in the electronics industry became acquainted with Collins through the Company's superior Amateur equipment.



COLLINS in Broadcast

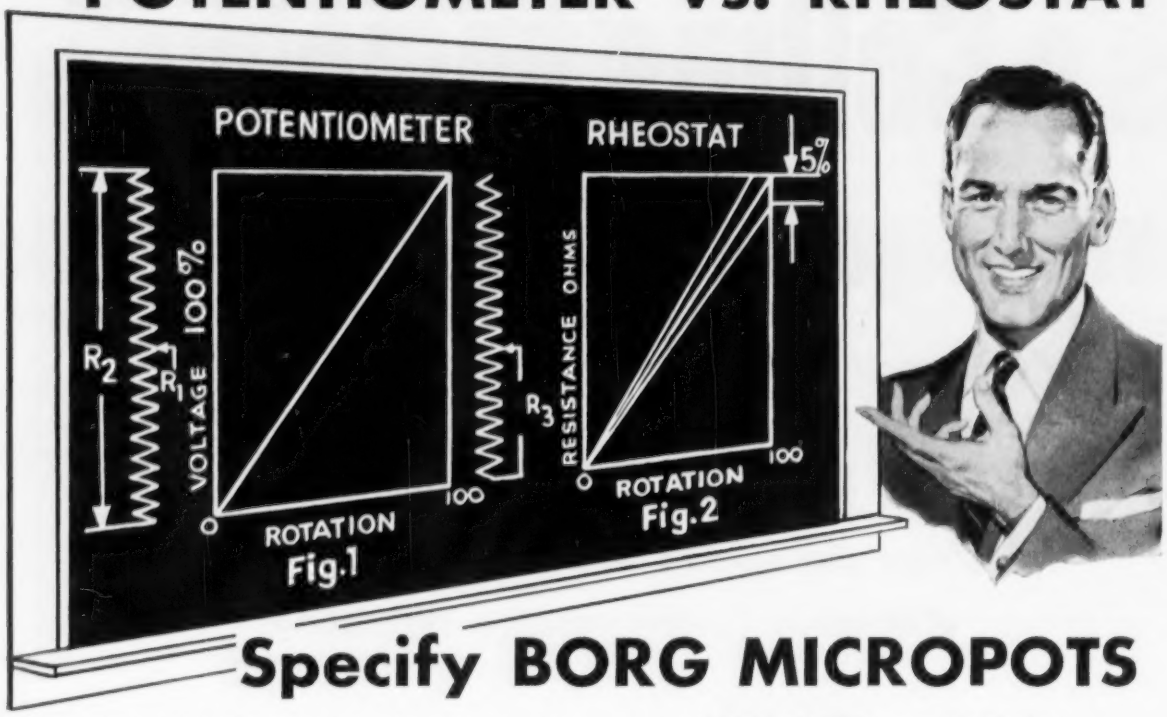
Collins supplies a complete new AM station from mike to antenna or modernizes existing facilities. Besides the superior line of transmitters, Collins supplies the broadcaster's needs with such advanced additions as TV-STL microwave relay system, the lightest 4-channel remote amplifier on the market, phasing equipment and audio consoles. Collins field service organization has built an enviable reputation in assisting the broadcaster in installation or in times of emergency.

Collins CREATIVE LEADER IN ELECTRONICS

COLLINS

Collins Radio Company — Cedar Rapids • Dallas • Burbank

POTENTIOMETER Vs. RHEOSTAT



Specify BORG MICROPOTS

Potentiometer Vs. Rheostat. Potentiometers should be used whenever possible to reduce systems error and excessive cost. Here's why.

POTENTIOMETER as a POTENTIOMETER

Definition: A potentiometer is a voltage divider.

Accuracy — Potentiometer accuracy is determined by the ratio of R_1 to R_2 for any given position of the control shaft (Fig. 1). Potentiometer accuracy is *independent* of total resistance. Commercial precision potentiometers are designed for use as voltage dividers. Therefore, the total resistance is ± 5%. However, the output voltage is the ratio of R_1 to R_2 and provides a linearity accuracy of 0.1% (Fig. 1). Linearity accuracy in commercial precision potentiometers is 0.1%.

POTENTIOMETER as a RHEOSTAT

Definition: A rheostat is a variable current control.

Accuracy — When used as a rheostat (2 wire hookup) the accuracy of the potentiometer is determined by the absolute resistance R_3 for any given position of the control shaft (Fig. 2).

Rheostat accuracy is *dependent* upon the absolute resistance at any point.

Commercial precision potentiometers, when used as rheostats, have an absolute ohmic resistance R_3. It may deviate from zero to 5% from theoretical over the range of zero to 100% of shaft rotation (Fig. 2). Errors in distribution of this resistance (comparable to potentiometer linearity tolerance) must be added to this error to ascertain the "total ohms per degree conformity", the true measure of rheostat accuracy.

Consider the possibility of a closer total resistance tolerance to provide greater accuracy when used as rheostats. Commercial tolerance on fixed resistance is 5% with special selected values to 1%. This selected accuracy, if duplicated in a rheostat, would still be 10 times greater than the standard 0.1% accuracy of the commercial potentiometer. Factors which contribute to the difficulty in tight total resistance tolerances in fixed resistors are: resistance stability, temperature coefficient, and the absolute ohmic value of commercially available resistance alloys.

These limiting factors apply to potentiometers used as rheostats. This increases the cost of such units just as the cost of tight tolerance fixed resistors is considerably greater than standard tolerances.

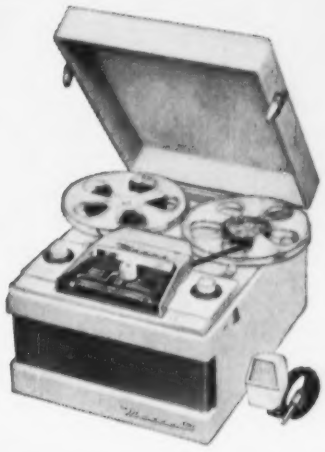
We have found, through years of building potentiometers, designing equipment and in consultation with customers, that when systems can be designed to use potentiometers in place of rheostats, greatly increased accuracy results and usually the cost is reduced.

Write for Complete Engineering Data • CATALOG BED-A56

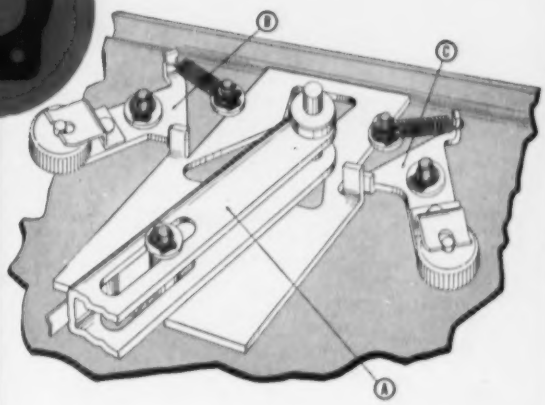
BORG EQUIPMENT DIVISION
THE GEORGE W. BORG CORPORATION
JANESVILLE, WISCONSIN

ELECTRONIC – MECHANICAL BORG EQUIPMENT — Built by Borg

Waldes Truarc grip rings used on die-cast studs eliminate threading, tapping, other costly machining



Mark Simpson Manufacturing Co., Long Island City, N. Y., uses Waldes Truarc series 5535 Grip Rings to secure parts to studs of the zinc die-cast base of its "Masco 500" portable tape recorder.
The rings—which need no grooves—replace nuts, screws, cotter pins and other types of fastening devices which require threading, tapping, drilling and other expensive machining operations. Because a single cracked or broken stud would render the entire cast base useless—and with it, all assembly completed to that point—the rings also eliminate extremely costly rejects.



Pivot Assembly of shift lever (A) is secured by a single Waldes Truarc Grip Ring and washer. Because the washer must be installed over the shift level in a sliding fit, critical tolerances would have to be maintained if a screw or cotter pin were used. The Truarc Grip Ring eliminates that problem: it requires no groove and may be seated over the washer at any point on the stud, automatically compensating for accumulated tolerances in the parts. BRAKE ASSEMBLIES (B and C) use Grip Rings to secure the brake wheel and spring subassemblies. Here again problems of critical tolerances are avoided and expensive rejects eliminated.

Whatever you make, there's a Waldes Truarc Retaining Ring designed to improve your product... to save you material, machining and labor costs. They're quick and easy to assemble and disassemble, and they do a better job of holding parts together. Truarc rings are precision engineered and precision made, quality controlled from raw material to finished ring.

36 functionally different types... as many as 97 different sizes within a type... 5 metal specifications and 14 different finishes. Truarc rings are available from 90 stocking points throughout the U. S. A. and Canada.

More than 30 engineering-minded factory representatives and 700 field men are available to you on call. Send us your blueprints today... let our Truarc engineers help you solve design, assembly and production problems... without obligation.

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Waldes Kohinoor, Inc., 47-16 Austel Place, L. I. C. 1, N.Y.
Please send the new supplement No. 1 which brings Truarc Catalog RR 9-52 up to date.
(Please print)

Name _____
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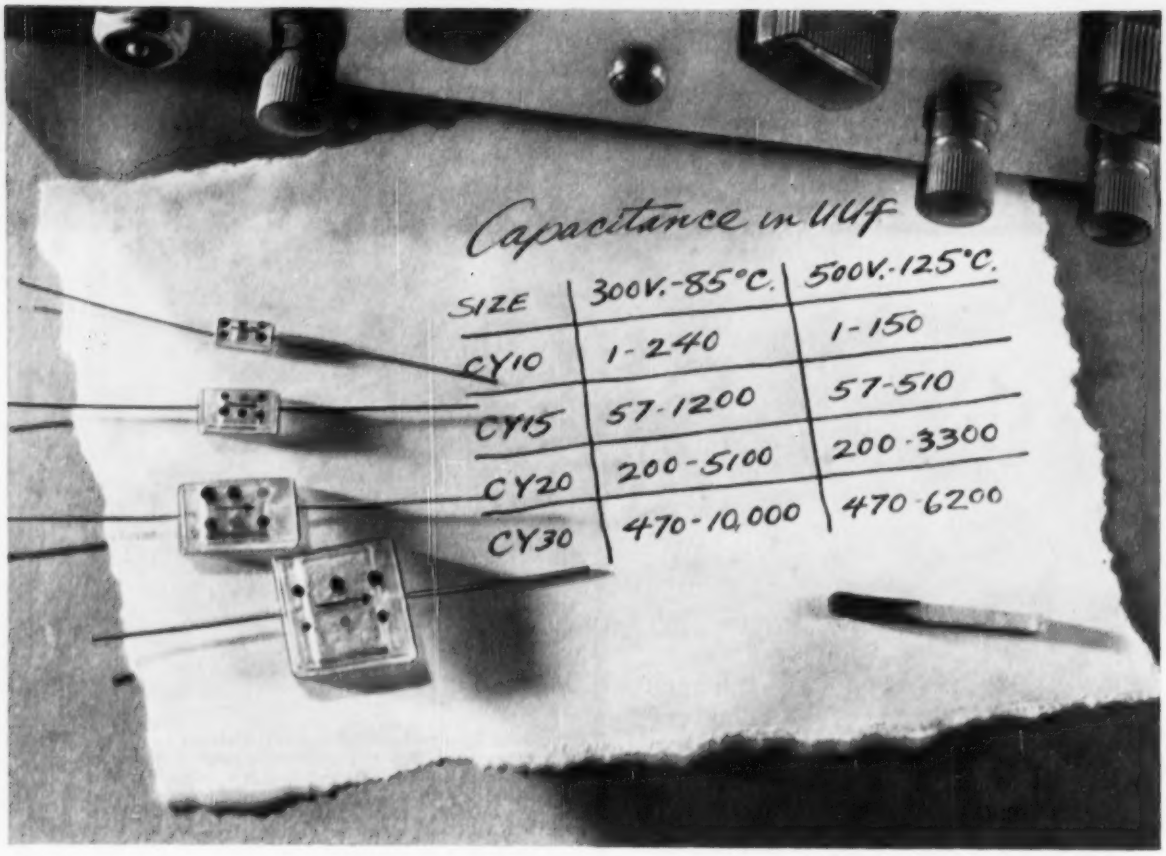
City _____ *Zone* _____ *State* _____

WALDES TRUARC Retaining Rings, Grooving Tools, Pliers, Applicators and Dispensers are protected by one or more of the following U. S. Patents: 2,382,948; 2,411,426; 2,411,761; 2,416,852; 2,420,921; 2,428,341; 2,439,785; 2,441,846; 2,455,165; 2,483,379; 2,483,380; 2,483,383; 2,487,802; 2,487,803; 2,491,306; 2,491,310; 2,509,081; 2,544,631; 2,546,616; 2,547,263; 2,558,704; 2,574,034; 2,577,319; 2,595,787, and other U. S. Patents pending. Equal patent protection established in foreign countries.

See the Truarc Exhibit at the Design Engineering Show, New York Coliseum, May 20th to May 23rd. Booth No. 1010.



uuf for *uuf*, the smallest, most stable, fixed capacitors you can buy—Here's why...

These are *glass* capacitors—probably as much as one-third smaller than those you're used to; certainly much lighter.

Though made with glass, they are *not* fragile. In fact, the layers of glass dielectric, the metal foil plates and the leads are fused into a surprisingly rugged, inseparable unit.

This unusual construction, developed at Corning offers you these advantages:

Small size, light weight. If you're at work on guided missiles, fire controls, computors, and similar devices, you can cut valuable ounces and inches from your assemblies with these capacitors. See table above for some indications.

Exceptional stability. After a load life test at 50% more than rated voltage at 85° C., the average change in capacitance of these units is less than 0.4% after 1,000 hours, less than 0.6% after 10,000 hours.

Capacitance in uuf

Size	300 V. —85° C.	500 V. —125° C.
CY10	1-240	1-150
CY15	57-1200	57-510
CY20	200-5100	200-3300
CY30	470-10,000	470-6200

Very low drift. This drift is so slight that it's generally within the normal error of measurement. Taking MIL-C-11272A as a standard, capacitance drift is less than 0.1% or 0.1 *uuf* (whichever is greater).

Predictable, retraceable TC. The difference in TC between any units at any given temperature is less than 15 ppm/° C. It is well within the limits of 140 ± 25 ppm/° C. from −55° C. to +85° C. and referred to 25° C.

Low loss. Even at elevated temperatures, the dielectric loss is relatively low. Dissipation factor at 1 kc. and 25° C. is about 0.055% and independent of capacitance.

Bulletin shows performance charts. Bulletin CD-1.00 contains charts and other data on these capacitors. Circle this magazine's service card for a copy or write us direct at Corning.

Ask for information on these other Corning Capacitors:

Medium Power Transmitting—CY60 and CY70. Ideal for mobile RF transmitters.

Canned High Capacitance—Provide the advantages of rugged glass design to your specifications.

Subminiature Tab-Lead—Up to 90% less volume compared to pigtail types. To your specifications.

Special Combinations—The performance and benefits of glass in infinite shapes, sizes and leads. To custom order.

Other electronic products by Corning Components Department: Glass Film Type Resistors*. LP, LPI, H, R, N, S, HP and Water Cooled Styles. Direct Traverse and Midget Rotary Trimmer Capacitors*. Metallized Glass Inductances, Delayline Coil Forms, Bushings, Enclosure Tubes, Rectifier Tubes and Attenuator Plates. **Distributed by Erie Resistor Corporation*

Corning means research in Glass

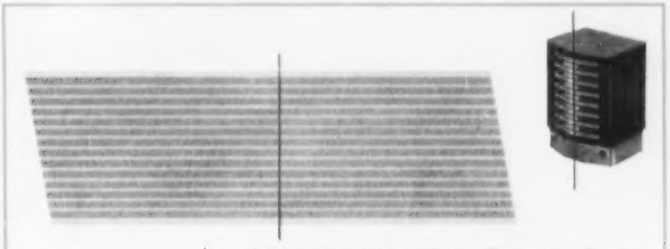
CORNING GLASS WORKS, 94-5 Crystal Street, Corning, N. Y.

Electronic Components Department

How many microseconds apart is "almost simultaneous"?

Here is how magnetic tape gets the answer

When things happen in the front of a jet engine, other occurrences in the rear follow in a flash – no pun intended, we mean in a fraction of a millisecond. Those who test jet engines have found that magnetic tape recording can be used to make a *milli*second look enormous – and to show even fifteen *micro*seconds as a significant interval. Transducers in key points in the front and rear of the engine feed parallel tracks on the tape. The amount of offset between parallel signals provides a measure of their relative timing.



Microscopic precision of gap alignment and azimuth enables magnetic tape to record extremely accurate track-to-track time relations.

For time correlation the head stacks on an Ampex Tape Recorder are like an "electronic tee-square." All of the gaps are in line within 1/10,000th inch. And gap azimuth is accurate to a minute of arc. Tape moves past the head at speeds up to 60 inches per second and multiplies the track-to-track timing accuracy accordingly. (But consult us at Ampex before you rely on simple arithmetical conclusions).

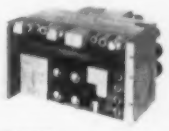
To read these time differences off in measurable form, the tape is reproduced at a small fraction of its original speed (1/32nd, 1/100th, etc. according to machine). It can be recopied onto another tape – be slowed down again – and then be recopied onto a visual recording on which small time intervals are magnified as much as 10,000 times.

If to you this particular example is more spectacular than useful, note that it is only one of numerous talents that magnetic tape has in tying together data and time. Perhaps some of these others fit your needs.

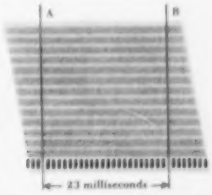
Are you interested in reproducing data in precise real time? Ampex Servo Speed Control can reproduce data with original timing held within two parts in 100,000. It doesn't matter if the tape stretches a little, or if your input power fluctuates from 60 cycles. Servo Speed Control holds a precision signal on the tape in step with a precision time source. At any instant these signals will be in phase within a millisecond or less (depending on tape speed).

Maybe you like your data recordings referred to the time of day. In any of several forms of digital coding, such information fits nicely on a timing track. The time code designates hours, minutes, seconds and even the milliseconds between. Commercial equipment is available for search and control. It can run the tape quickly to any minute and second you designate – handy if your recordings accumulate by tens or hundreds of thousands of feet.

If quick, accurate measurement of time intervals from a fractional second to a few seconds in length are your interest, magnetic tape recordings can make the problem as easy as counting to 1,254,391 . . . on an electronic counter. A series of pulses or sinewave oscillations are recorded on a time track parallel to the data tracks. As many as ten thousand per second can be recorded accurately and reliably. Electronic counting of these pulses measures time intervals to a required precision. There is no strain on your patience or your eyesight.



Ampex Servo Speed Control equipment as used on the FR-100 Recorder.



Electronic counting on a timing track measures time intervals between data

If you are concerned with accurate timing of data and would like to know further of magnetic tape's advantages, we will be glad to furnish additional information. Others of magnetic tape's capabilities will be discussed in this continuing series. Would you like copies mailed direct? Write Dept. E-5.

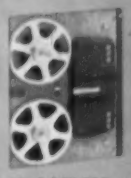
MAGNETIC TAPE APPLICATIONS BY AMPEX

3

ONE OF A SERIES

Series FR-100

Series 800 Mobile and Airborne



Model FR-200 Digital

Tape Loop Recorder

Series FR-1100

INSTRUMENTATION DIVISION

AMPEX CORPORATION

FIRST IN MAGNETIC TAPE INSTRUMENTATION

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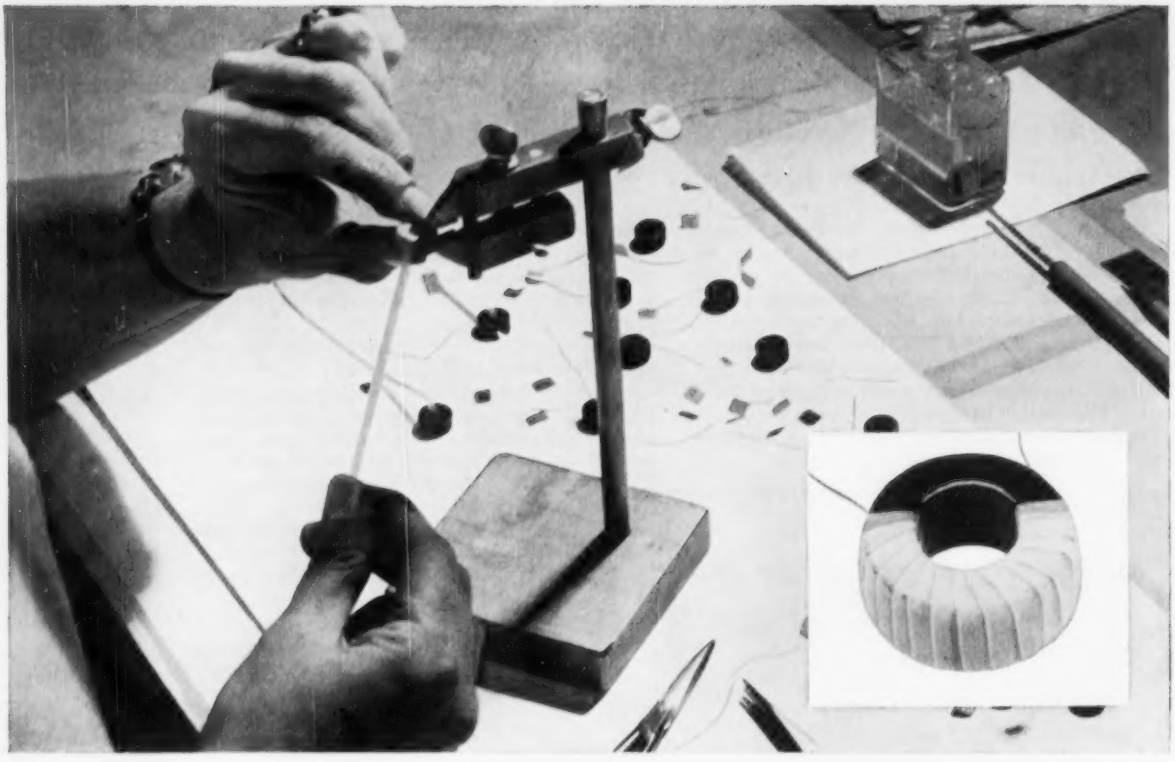
District offices serving all areas of the United States and Canada; Foreign Representatives in countries around the world.



How R/M Teflon* Tape improves electronic component design

Has high dielectric strength • conforms to intricate shapes

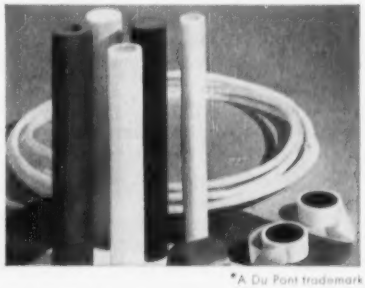
Certain coils in a modern electronic computer required a special kind of insulator. Problem: to design an insulator of the high dielectric strength required—even in thin sections—and conforming to the contours of the small circular coils.

R/M "Teflon" Tape provided the ideal solution to the problem. "Teflon" has unusually high dielectric strength. It is completely unaffected by the many adverse conditions to which electronic components are frequently subjected—corrosive elements (including ozone) in atmospheres, high temperatures, and the like. R/M "Teflon" Tape is relatively easy to apply—even on intricate shapes, such as the ferrite coil shown above.

Here are some of the electrical properties of R/M "Teflon" products:

1. **Power factor** — less than 0.0003 over entire spectrum from 60 cycles to 30,000 megacycles.
2. **Volume resistivity** — greater than 10^{15} ohm-cm, even after prolonged soaking in water.
3. **Surface resistivity** — 3.6 x 10^{12} ohms, even at 100% humidity.
4. **Good arc-resistance** — on exposure to an arc, the material vaporizes, leaving no carbonized path.
5. **High short-time dielectric strength**—values range from 1000 to 2000 volts per mil, depending upon thickness.
6. **Resists high temperatures** — electrical properties are essentially unchanged up to at least 400°F.

Raybestos-Manhattan has extensive experience in developing R/M "Teflon" products for use in the electrical and electronics industries. Let us fabricate R/M "Teflon" products to your specifications or supply the material in rods, sheets, tubes and tape. Write for your free copy of our bulletin "R/M Teflon Products."



*A Du Pont trademark

RAYBESTOS-MANHATTAN, INC.

PLASTIC PRODUCTS DIVISION, MANHEIM, PA.

FACTORIES: Manheim, Pa.; Bridgeport, Conn.; No. Charleston, S.C.; Passaic, N.J.; Neenah, Wis.; Crawfordsville, Ind.; Peterborough, Ontario, Canada

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Centralab 1922 1957 35 YEARS

Since 1922, industry's No. 1 source of standard and special electronic components

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Rotary Power

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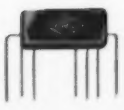
Single stage

Four stage



Handles a Kilowatt with ease

Centralab Series PA-230 Rotary Power Switch

The most versatile multiple-circuit rotary power switch available

Switching configurations up to 24 positions, shorting or non-shorting. Meets all your requirements for transmitters, industrial test equipment, military and commercial applications where you want low-loss operation at high frequencies, high voltages, and high-power levels.

Designed for **ruggedness, accuracy, long life**

- **Sections are Grade L-5 Steatite Voltage breakdown, 3000 volts R.M.S. between critical parts.**
- **Ball-bearing index insures positive positioning.**
- **Square rotor shaft, combined with mating Monel driver, provides rotational accuracy throughout length of switch.**
- **Coin-silver contacts, for excellent current-carrying characteristics.**

Customer's problem: Needed 540 contact combination.

Solution: This 30-section Centralab Series PA-230 switch.

Centralab can solve *your* switch problems.

Centralab

A DIVISION OF GLOBE-UNION INC.

902 E. Keefe Ave.
Milwaukee 1, Wis.

In Canada:
804 Mt. Pleasant Road
Toronto, Ontario

Continued on next page . . .

. . . continued fr
preceding page

Smallest, **most versatile,** multiple-circuit rotary switch

Centralab Series 100

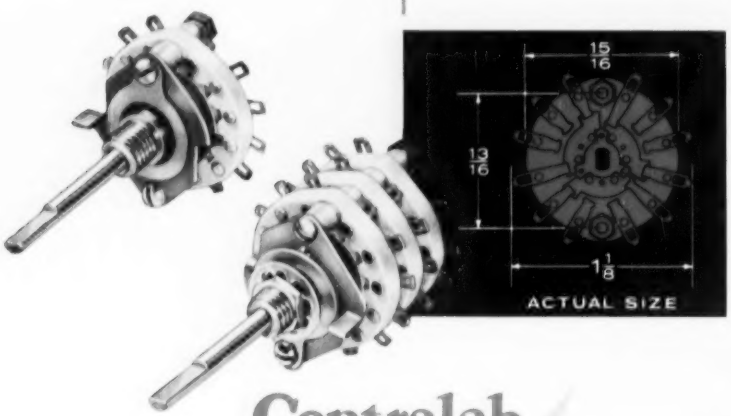
An ultra-small switch that measures less than 1" in diameter — weighs less than an ounce — yet has the electrical rating of larger, heavier switches.

Available up to 12 positions. Make and break, resistance load, .5 ampere at 6 volts d.c.; 100 milliamperes at 110 volts, a.c.; current-carrying capacity, 5 amperes.

Ideal for band switching in subminiature electronic equipment, transistor circuits, aircraft instruments, and guided missiles.

Features not found in phenolic-type switches

- Maximum voltage flashover
- High Q — Low loss
- Minimum inter-circuit capacity
- Maximum circuit flexibility



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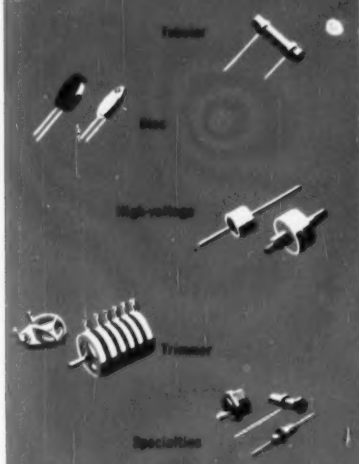
New 36-page Switch Catalog

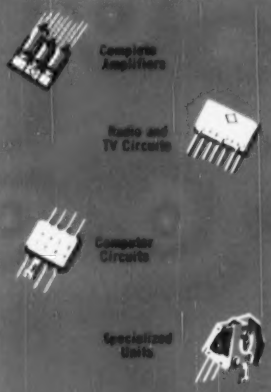
Provides specifications on the complete line of CRL switches capable of handling power from a kilowatt to a microwatt. Write for this catalog today.

Centralab 1922 1957 35 YEARS

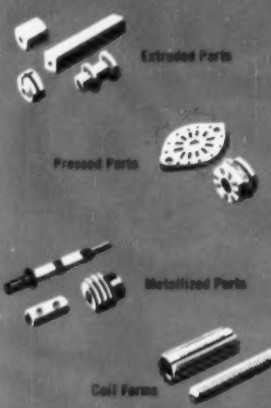
CERAMIC CAPACITORS



PACKAGED ELECTRONIC CIRCUITS



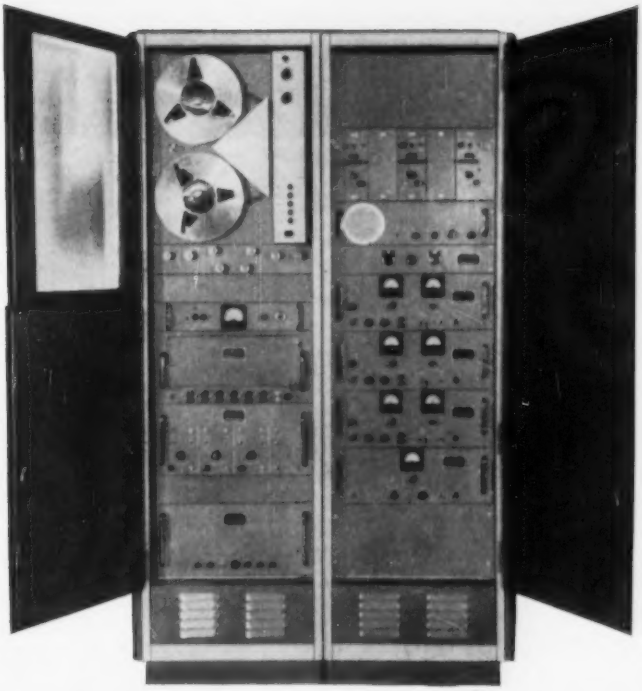
ENGINEERED CERAMICS



Hundreds of standard components are carried in stock by your nearby Centralab distributors.

Discuss your special requirements with the Centralab representative.

NEW UNIVERSAL SYSTEMS



meet 90% of magnetic tape data recording needs

You get all the precision and accuracy of a custom design *and* the off-the-shelf availability and dollar savings of a "package" design in Davies new Universal Tape Systems.

Every component has been designed to provide maximum flexibility consistent with overall system accuracy. Interchangeable electronics match the system to *your individual requirements* . . . now and for years to come. Specify a Universal System that satisfies your *immediate* requirements . . . adding tracks of data capacity as requirements grow.

Any one of the maximum of fifteen tracks provided can carry data recorded by any one of the three major techniques. Interchangeable Direct, FM, and PWM electronics assure you a *vital* data recording system . . . able to handle each new job as it arises. Standard options are also available to meet the special needs of telemetering and multiplexed data.

Among the features of a Davies Universal Tape System never before available in "package" equipment are six tape speeds at the flip of a switch . . . automatic switching discriminators that match tape speed at the transport . . . precise phase coincidence of data among all tracks . . . and facilities for electronic flutter-and-wow compensation. Every item has been proved through years of service in jets, missiles, and on the ground.

Here's a brief rundown of the options available to you when specifying a Davies Universal Tape System that will grow with your recording requirements:

Transport: Standard transport offers up to six speeds, selectable at the flip of a switch. Precision 10½" or 14" reels available for 1" or 1½" tape. Three-speed transport optional for PWM systems.

Heads: In-line multitrack heads permit up to 15 tracks on 1½" tape, assure precise time and phase coincidence of data among all tracks. Separate record and playback heads provided. Interleaved head stacks permitting up to 30 tracks on 1½" tape, optional for telemetering, other applications not requiring data coincidence.

Direct Recording electronics record and playback data from 100 to 100,000 cps. Ideal for high frequency data, also for recording complex wave forms made up of many frequency multiplexed signal channels. Bandpass type discriminators provided for recovering multiplexed data.

FM electronics frequency modulate a stable carrier with the data, to provide extremely accurate data reproduction, independent of tape variations.

Pulse Width Modulation (PWM) electronics permit up to 90 channels of quasi-static data on each tape track. All PWM electronics are compatible with standard keyers and decoding equipment.

Flutter-And-Wow Compensation electronically eliminates the effects of tape speed variation. Included as standard equipment whenever discriminators are used for data recovery, they can be accommodated by every Universal Tape System. Compensation permits FM channels of a Universal Tape System to preserve a high signal-to-noise ratio—better than 50 db at 30 ips, for example.

COMPLETE INFORMATION *on Davies new Universal Tape Systems, and how they can satisfy your magnetic tape data recording needs is provided in Bulletin 2701. Write for your copy to Minneapolis-Honeywell Regulator Co., Davies Laboratories Division, 10721 Hanna Street, Beltsville, Maryland. Or call Webster 5-2700.*

MINNEAPOLIS **Honeywell**

DAVIES LABORATORIES DIV.

Obtain your Scotch Brand recording tape for all instrumentation recording needs at your nearest Honeywell Industrial Sales Office.

MICRO SWITCH Precision

...FIRST IN PRECISION SWITCHING

Over 200 MICRO SWITCH Precision Switches help make Lockheed's C-130 Hercules a superb military plane

MICRO SWITCH Engineering Service cooperated with Lockheed engineers of the Georgia Division, Marietta, Ga., for five years in the designing, planning and manufacturing of this plane—the first propjet transport accepted by the U. S. Air Force.

Over 200 precision switches at strategic points perform important functions in the operation of this superb aircraft. Other MICRO SWITCH precision switches are employed in components for this plane supplied by other manufacturers. Still others provide important controls for the machine tools used in the building of the C-130 itself.

Whatever your design—be it aircraft, machine tools, or any type of industrial equipment—MICRO SWITCH components and MICRO SWITCH Engineering Service may help you make a good design even better.

MICRO SWITCH reputation for reliability, precision and performance is written in the success of such products as the Lockheed Hercules and thousands of fine industrial products. MICRO SWITCH Engineering Service is as close as your telephone. Why not call the nearest branch office today?

Wide variety of switch types in the Hercules

Series VA Enclosed Switches
These combine the features of sealed construction and high electrical capacity. They are available with roller arm or lever actuators.

Series V3 Basic Switches
These have the highest electrical capacity for their size of any switch available. Are available in wide variety of terminal designs, contact arrangements and operating characteristics.

Series SE Sealed Subminiature Switches
These are the smallest and lightest completely environment-free precision switches available. They are built to give trouble-free operation in a temperature range of from —65°F to +212°F.

Series DT Double-Pole Double-Throw Switches
These switches simultaneously make and break two independent circuits. The double-pole double-throw switches are rated for 10 amps. 125 or 250 v ac; ½ amp. 125 v dc; ¼ amp. 250 v dc. Temperature rise limits maximum continuous current to 10 amperes per pole.

Switches have uses unlimited

Here's a tough switch to take the roughest going

The MICRO SWITCH sealed Type EN switch was designed to meet tough aircraft problems. Its many unusual features are now meeting many exacting industrial design requirements.

How good is this switch? Check your requirements against tests like these:

- Precise performance at minus 65°F or heated to plus 180°F. (Operating force to 20 lbs. available to facilitate ice breaking.)
- Precise performance after 100 hours in salt brine spray.
- Precise performance after hours of immersion under 36 in. head of alternating iced and heated water.
- Precise performance unaffected by 30 days' operation at 104°F and 95% humidity.
- No chattering of contacts—or loosening of parts—during vibration tests of 10 to 500 cycles per second.

(Send for Catalog No. 77)

Hermetically sealed basic switch insures constant performance

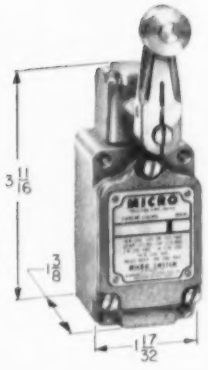
This small MICRO SWITCH Type HS precision switch is truly hermetically sealed (glass to metal and metal to metal) to insure constant operating characteristics under any environmental conditions—for example, no condensation problem.

The switch shown has a lever type actuator for inline motion operation. The switch is also available with a roller-lever actuator suitable for actuation by cams, slides or other mechanical means.

Characteristics of Switch Shown

Operating force—10 to 22 oz.; Release force—4 oz. min.; Overtravel—.010 min.; Differential travel—.020 in. max.; Weight—1.5 oz.

Electrical Characteristics—28 volts dc—inductive 10 amperes; resistive 25 amperes; 125 volts ac—inductive 1 ampere; resistive 1 ampere. (Send for Catalog No. 77)



Sealed—Reliable—Versatile—Give millions of operations

The MICRO SWITCH Type LS is a small two-circuit switch which meets a wide variety of industrial design requirements. It is extremely reliable, ruggedly housed and can be mounted in almost any location. Actuator head may be removed in the field and rotated to permit actuation from any of the four quadrants. The roller-arm actuator is field adjustable through 360°. It may operate in either direction, or one direction only.

The electrical rating is: 10 amperes 120, 240 or 480 volts ac; ½ H.P. 120 volts ac; 1 H.P. 240 volts ac; .8 ampere 115 volts dc; .4 ampere 230 volts dc; .1 ampere 550 volts dc. Pilot duty rating is 600 volts ac maximum.

(Complete information in Catalog 83)

MICRO SWITCH, a Division of Honeywell, pioneered the manufacture and development of precision snap-action switches

MICRO SWITCH

A DIVISION OF MINNEAPOLIS-HONEYWELL REGULATOR COMPANY

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Can We Afford a $71.8 Billion Budget?

THE BUDGET submitted to Congress by President Eisenhower for the year beginning July 1 proposes federal spending of $71.8 billion. In only four years, three during World War II and one during the Korean War, has the government spent more. Under the proposed budget the government expects to collect $73.6 billion, mostly through individual and corporation income taxes.†

The principal reason for the size of the budget and for this year's increase is an expanding defense program. About 60% of all budget expenditures in the coming fiscal year will be for national security programs. Moreover, this area accounts for about 90% of the proposed increase in federal spending. In addition, as the chart shows, there are large expenditures proposed for purposes other than defense.

Continued budgets of this size, some contend, will lead to inflation and wreck our economy. It has been suggested that they might lead to "a depression that will curl your hair." Yet many insist that the budget, large as it is, still is inadequate in many respects — for defense, schools, agriculture, small business, health, research, indeed, for almost every activity in which the government has become involved.

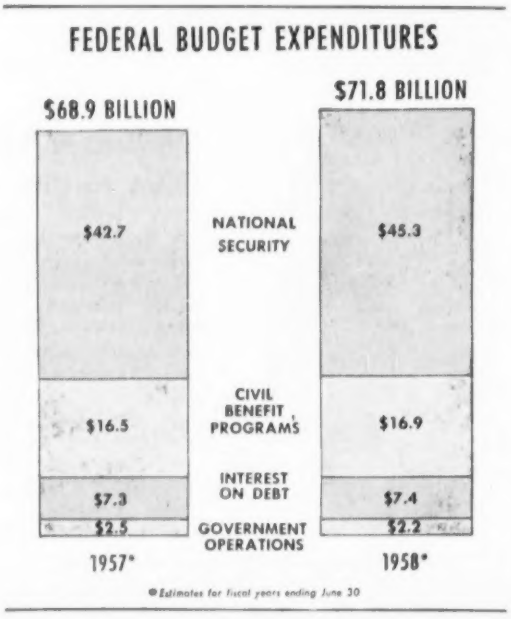
Is It Really Too Big?

Actually, the proposed budget would place no greater burden on the economy than any budget in the last six years, because our economy has been growing. Federal spending per capita under the proposed budget will be about $416, or $10 more than this year; but our per capita income rose almost $80 last year. And, because of our increasing population, next year's expenditures will, in fact, amount to *less* per capita than in 1954 when federal spending was $4 billion lower.

Another way of measuring the burden of government expenditures on the economy is to compare the purchases of goods and services of all branches of government — federal, state and local — with the total output of the nation. The share of our national product taken by government this year will be about the same as in the past two years and, furthermore, about the same as the average for the past 28 years.

By the standard of any recent year, the budget is within the means of the American economy. In this sense, we can "afford" it. But the pros-

†*These figures refer to the regular federal budget and do not include operations of trust funds, primarily for social security programs and the new federal aid program for highways, which are financed by special taxes.*



pect of steadily increasing budgets, requiring 20% or more of our national income, introduces another threat.

The Real Threat

Large and rising budgets that do not balance government spending with higher tax collections clearly would be inflationary and would destroy the value of the savings and income of all who lagged in the race with climbing prices. But serious dangers will still exist even if our budget continues to be balanced, as this year's is.

- **Budgets that require a large take in taxes eat up the savings required to finance private industry.** What the taxpayers must give the government they cannot save. This deprives private industry of the savings and resources needed to expand and modernize producing facilities.
- **High tax rates also undermine the incentive to save and invest in normal business enterprises by taking such a large share of any income gained.** Taxes on corporation income now take 52% of all income over $25,000. And taxes on individual incomes can take as much as 90% of earnings that remain after this 52% bite.
- **High taxes encourage, on the part of both individuals and corporations, the search for "gimmicks" and special treatment.** As a leading character in Cameron Hawley's novel *Executive Suite* observed: "To a far greater degree than most people realize, income tax has become a primary governing factor in corporation management." Indeed, it is only because of the numerous gimmicks and special provisions now available that high tax rates have not already inflicted greater damage to economic incentives.

These dangers comprise the real threat of large and rising federal budgets. It is a threat to continued growth of our economy, and it is no less a threat merely because the budget is technically in balance.

What Should Be Done?

In attempting to hold government spending within reasonable bounds, we should *not* hold back on needed civilian programs. The heavy demands now being urged at all levels of government for roads and schools, for instance, are largely the result of failure to keep pace with the growth of the country. Furthermore, we cannot cut provisions for national security below the minimum level of safety. And unhappily, defense in the rocket and missile age is fantastically and ever increasingly expensive.

What we *can* do is enforce some financial discipline on our military leaders, and hold down our defense expenditures by making sure their demands are justified and by requiring efficiency. In the civilian programs, though some need to be increased to serve a growing economy, we can eliminate the outright waste.

A More Difficult Job

We must also do something far more difficult, and that is to reduce federal programs of aid to special groups at the expense of all the taxpayers. The new budget calls for over $5 billion for veterans, and another $5 billion for farmers. A number of industries and areas stand to receive aid in large amounts based less on necessity than on political pressure. These demands for increased aid, year after year, must be resisted if we are to have any hope of stopping a relentless rise in our budget.

Then, as our national income increases, we can look forward to reducing tax rates and providing greater incentives for the private sector of the economy. **Only in this way — by keeping government spending in line with economic growth — can we prevent our federal budget from being a crippling burden.**

This message is one of a series prepared by the McGraw-Hill Department of Economics to help increase public knowledge and understanding of important nation-wide developments. Permission is freely extended to newspapers, groups or individuals to quote or reprint all or parts of the text.

Donald C. McGraw

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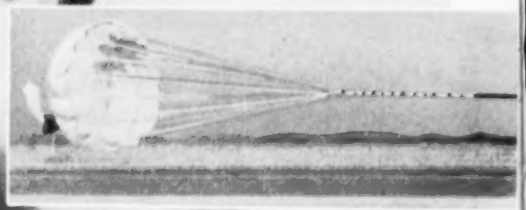
ROUND-TRIP MISSILES ANSWER



ENGINEERS' QUESTIONS AT VOUGHT

"Old Indestructible" Paid a $3 Million Dividend in Data

When a missile can be flown . . . recovered . . . and flown again, it becomes an acquaintance. When a single Regulus I missile came home 15 times, it got a name.

"Old Indestructible" began her career by returning flight test information to Vought engineers. The missile gave the acid test to new launching methods, guidance principles, performance maximums and telemetering channels. Three flights, and the bird had paid for herself in fat data installments.

When the missile had been picked clean by Vought reliability and systems men, she joined the Navy. Fleet submariners and surface seamen were ready to operate Regulus as a target drone and nuclear weapon. Old Indestructible was chosen to teach them.

The missile qualified six Navy teams in Regulus tactics, logistics and maintenance. Repeated launchings at 70,000 pounds thrust stretched her airframe. Flight and ground-run time on some components mounted above 1,000 hours. Operationally, however, the missile was sound when time came for her 16th and final flight, a shipboard launching in a simulated nuclear attack.

Thanks to Old Indestructible's dogged returnability, Vought engineers could design its reliability standards into every Navy-bound Regulus. Results were unprecedented. With the Fleet, Regulus I has completed its 500th successful flight with outstanding on-target success probability.

Today, Vought missile men are using the recovery concept to foolproof a mightier missile. Their Regulus II has completed 13 flights to date. Significantly, six of these flights were made by one missile.

Guidance Engineer. Develop and design radar, magnetic, inertial, infrared, animal and other guidance and recognition systems beyond present state of art. Requires ingenuity and analytical ability, with degree and experience in development engineering or physics.

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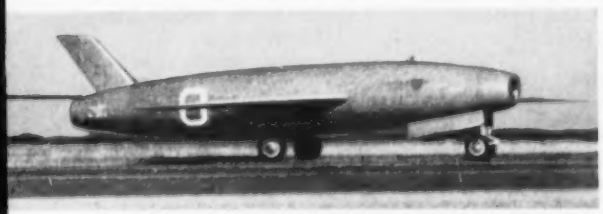

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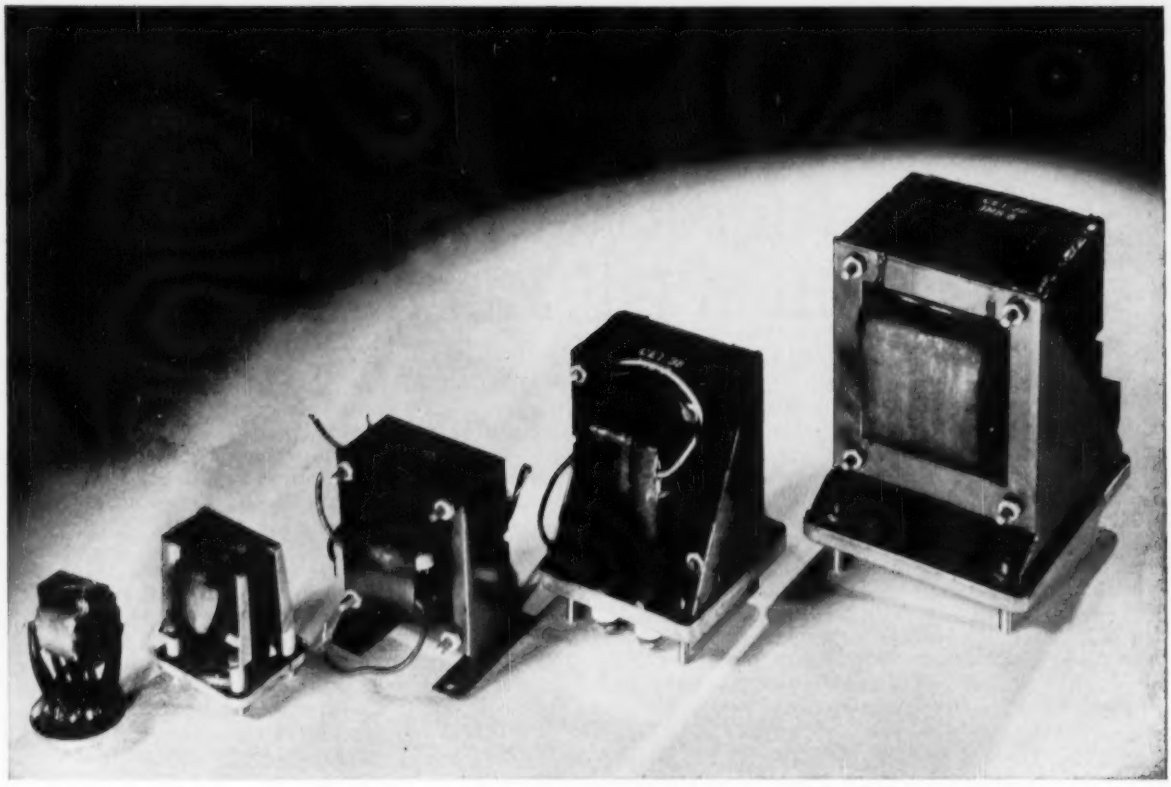

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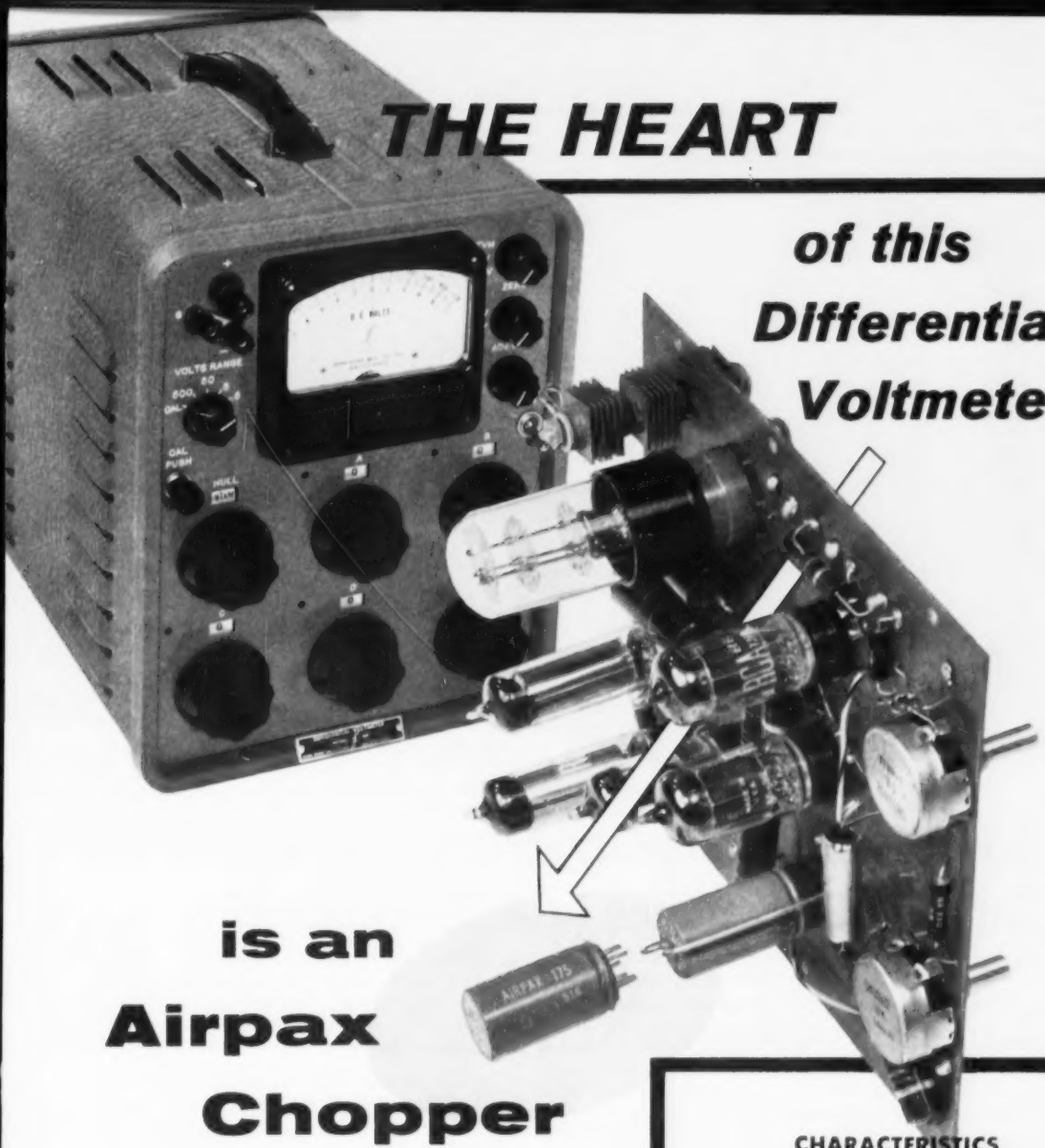
THE HEART

of this Differential Voltmeter



is an Airpax Chopper

A chopper amplifier extends the range of this null-reading VTVM down to 0 ± 0.01 DC volt. An Airpax Type 175 chopper modulates the input signal at 60 CPS so that it can readily be amplified and then the chopper synchronously rectifies the signal and returns it to the DC portion of the meter.

Here is another example of how a reliable chopper helps provide the stability essential to modern electronic equipment. This particular instrument is one of the precision laboratory meters developed by John Fluke Manufacturing Co., Seattle, Washington.

Type 175 chopper is one of the Airpax family of miniature choppers. For full details just write to

CHARACTERISTICS OF TYPE 175 CHOPPER

Drive

Frequency	60 ± 3 CPS
Voltage	6.3 ± 0.6 RMS volts

Contacts

Dwell Time	167 ± 10 electrical deg.
Balance	within 15 electrical deg.
Phase angle	20 ± 5 electrical deg.
Voltage	up to 100 DC volts
Current	up to 2 MA
Noise	50 microvolts average
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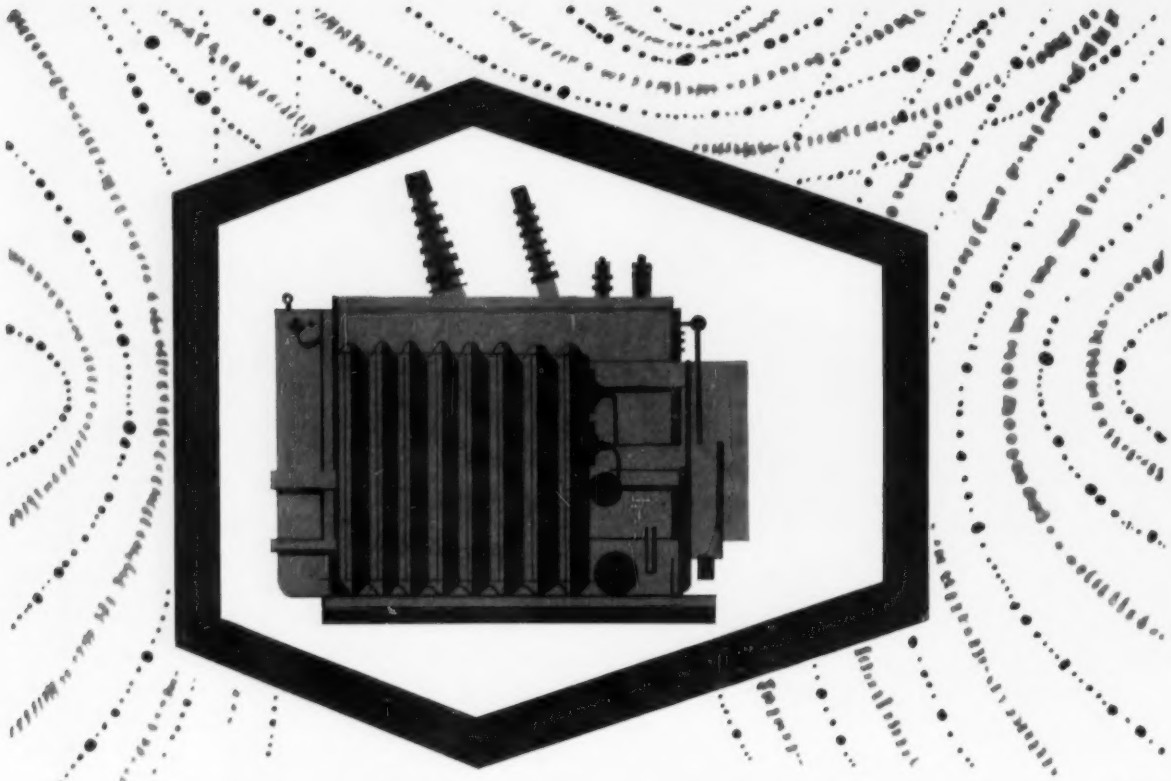

how Westinghouse stretches transformer life through R-F studies in ACE enclosure

R-F interference which often occurs in power transformers comes under strict regulation by both the FCC and military authorities. Standardized tests have been set up to check this interference against allowable limits. But at Westinghouse Electric Company's new Transformer Test Center at Sharon, Pa., engineers go on to use these measurements of radio frequency to actually improve the life of transformers.

When r-f generation occurs in a transformer, it releases ionized gasses which have a deleterious effect on the transformer windings. Reducing, or eliminating the cause of gas ionization, indicated by the generation of r-f interferance, greatly increases transformer life.

To make the accurate radio frequency measurements required, both the transformers and the delicate test instruments must be isolated from all sorts of outside radiations. A large Ace shielded enclosure—measuring 28 feet long, 32 feet wide, and 25 feet high—fulfills this requirement by providing a guaranteed attenuation of over 100 db for all frequencies from 14 kc to 1000 mc.

This Ace enclosure is constructed of prefabricated galvanized steel panels and frames (RFI-Design)* which assures permanent warp-free protection. A unique feature of the enclosure is its 16- by 20-foot electrically operated vertical lift door. Air-operated contact fingers around the periphery completely seal the door against r-f leakage.

This example of Ace enclosures for r-f shielding is just one of the many "rooms" Ace has designed and supplied to meet the requirements of industry, military, and medical work. If you have a shielding problem in your plant, an Ace Engineer would be glad to discuss it with you and outline an effective, yet economical solution. Or write for a free catalog on Ace standard enclosures.

*Lindsay Structure

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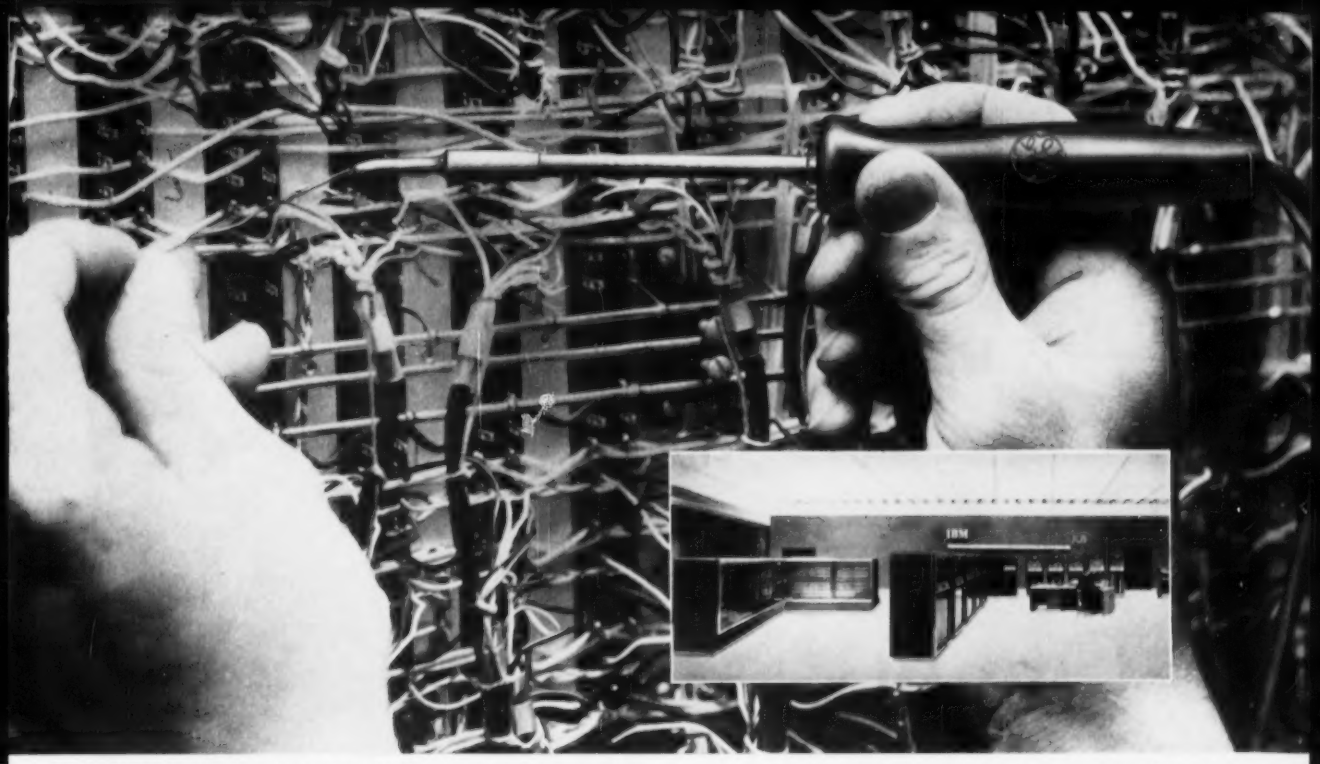

NEARLY 500 G-E MIDGET SOLDERING IRONS are helping to speed assembly of IBM's giant 704 and 705 "electronic brains" by providing fast, efficient heat to thousands of intricate joints. Each complex data processing machine demands perfectly soldered joints to assure dependable operation. IBM found that the G-E Midget irons provide excellent heat recovery, even with repetitive soldering. Result: uniform temperature with minimum loss of heat from joint to joint. Heat can be varied by simply setting transformer taps. In addition, the G-E Midget is multi-purpose, since tips are interchangeable. Its maneuverable, light-weight design speeds soldering, even in almost inaccessible areas, with reduced risk of damage to adjacent parts.

500 General Electric midget irons speed assembly of giant IBM "Electronic Brains"

IRONCLAD tip needs no filing. And by actual production-line test, a General Electric Midget soldering iron tip lasts up to ten times longer than an ordinary tip.

RAPID HEAT TRANSFER is achieved through a tubular heater located in the copper tip. Result: the General Electric Midget's heat efficiency is 90%.

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For more information, write for GED-2243, G-E Midget Soldering Iron, Section 724-6, General Electric Co., Schenectady 5, New York.

GENERAL ELECTRIC

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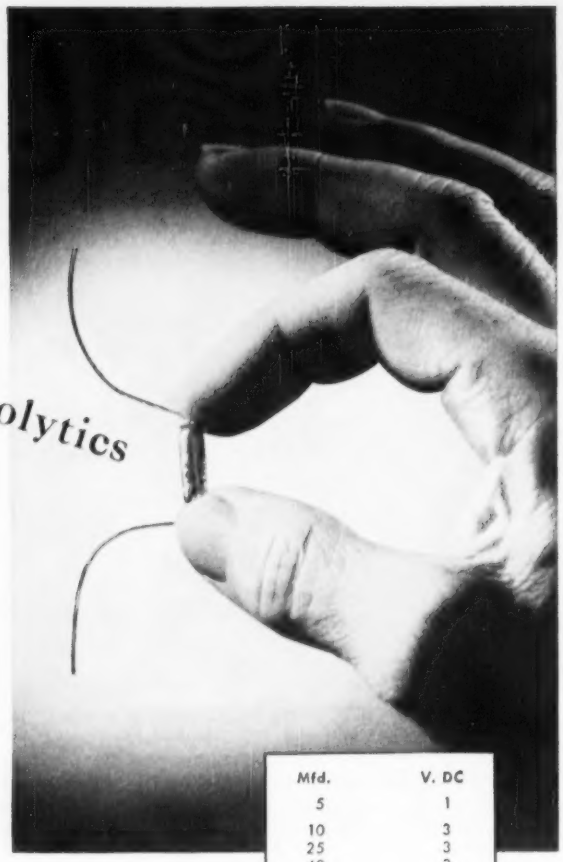

Mfd.	V. DC
5	1
10	3
25	3
40	3
110	3
2	6
5	6
8	6
10	6
15	6
25	6
30	6
40	6
50	6
60	6
15	10
25	10
1	12
2	12
5	12
10	12
10	15
20	15
30	15
5	25
8	25
15	25
20	25
5	50
10	50
20	50

Here's the newest addition to the Mallory capacitor line—a complete array of low-cost metal tubular aluminum electrolytic capacitors in miniature. Especially designed for the ever-widening field of miniature circuitry, these components are excellent for such equipment as transistorized pocket radios, midget recorders, and similar portable electronic gear.

Available in an extremely wide range of capacity and voltage ratings, these miniature capacitors are built to the same high standards of Mallory quality known the world over. Featured are the extremely small physical sizes and exceptionally low leakage current ratings—the latter, a very important factor in the design of battery powered equipment where battery drain must be held to a minimum.

The container for these miniature electrolytic capacitors is made of aluminum, with silicone rubber hermetic end seals. Capacitors can be supplied with vinyl insulating sleeves, if required. The leads are of No. 22 gauge bare tinned copper, $1\frac{3}{4}$ inches long. These capacitors have an operating range of -20 to $+65°C$. Actual size ranges from as little as $\frac{3}{16}$" diameter by $\frac{1}{2}$" long—to the largest, $\frac{3}{8}$" diameter by $\frac{3}{4}$" long.

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electronics

MAY 1 • 1957

CROSS TALK

CRYSTAL BALL . . . ELECTRONICS' 22 editors were asked at a home office meeting just before deadline to look into the immediate future of the industry. Here, unadorned, is what they said:

- The industry will continue to expand; no radical spurt, but steady upward progress.
- Money for missile control systems will be plentiful, but there may be losses in other military business.
- This will steadily increase interest in the commercial market.
- Pre-design market research will become more commonplace; manufacturers want to be more certain proposed new products will sell.
- More money will come into the field.
- One route will be via merger between electronic companies.
- Another will be continued acquisition of electronic companies by other groups seeking diversification into growth industries.
- This will make the going tougher for some small companies, but subcontracting will keep most of them in business and technical developments will bring new ones into the field.
- There probably will be more mortality among tv receiver makers.
- The year ahead may be generally distinguished by closer attention to operating costs.

On the technical side, the staff sees it this way:

- Increased application for transistors will probably be the year's most noticeable trend.
- Along with this trend will come further miniaturizing of component parts, and components suited to higher-temperature operation.
- There will be increasing emphasis upon mechanized wiring of all kinds.
- Pre-packaged circuits of the plug-in type will return to the news.
- Continuing pressure for equipment reliability will lead to more environmental testing of complete assemblies.
- Use of electronic machine control will be further stimulated by rising labor costs.
- Data processing systems for large business organizations will move forward at a rapid rate.
- Instrumentation for nuclear application will shape up importantly in dollars.
- New methods of communicating, and improvement of older methods, will return the spotlight to this branch of the electronics industry.

Now, let's see how this crystal-balling pans out.

W W MacDonald

Editor

By JAMES M. SNODGRASS
and
JOHN H. CAWLEY, Jr.

Special Development Division
Scripps Institute of Oceanography
University of California
La Jolla, California

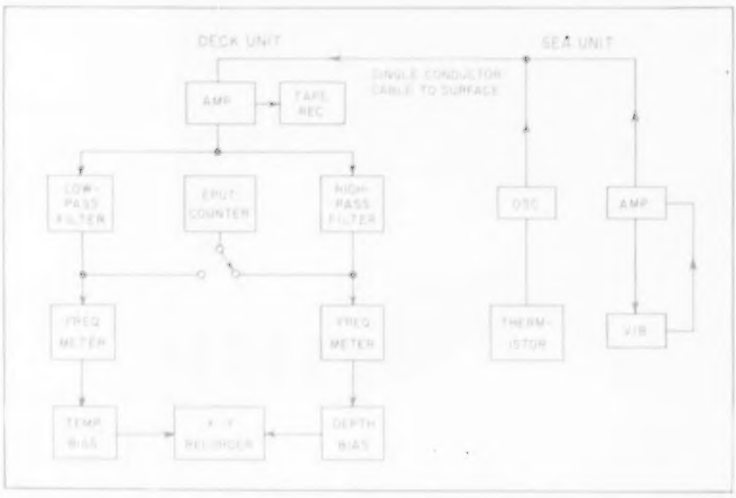


FIG. 1—Outputs of depth and temperature sensing systems are separated in high and low-pass filters for X-Y chart recorder

BATHYTHERMOMETER

SUMMARY —— Two-unit transistorized system lowered from ship gives plot of temperature against depth. Absolute accuracy in depth is better than ±0.25 percent and temperature sensitivity of 0.05 degree C can be obtained. Vibrating wire transducer and thermistor Wien-bridge oscillator provide depth and temperature data, respectively

OCEAN temperature as a function of depth provides valuable information for oceanographic studies. Previous methods of measurement by mechanical means provided an accuracy of ±0.5 C and ±5 ft in depth.

Resolution of the order of 1 ft in 1,000 in depth and 0.1 C in temperature are required in present-day oceanographic work. In addition, continuous profile recording is desirable. The system described here is one approach to this problem.

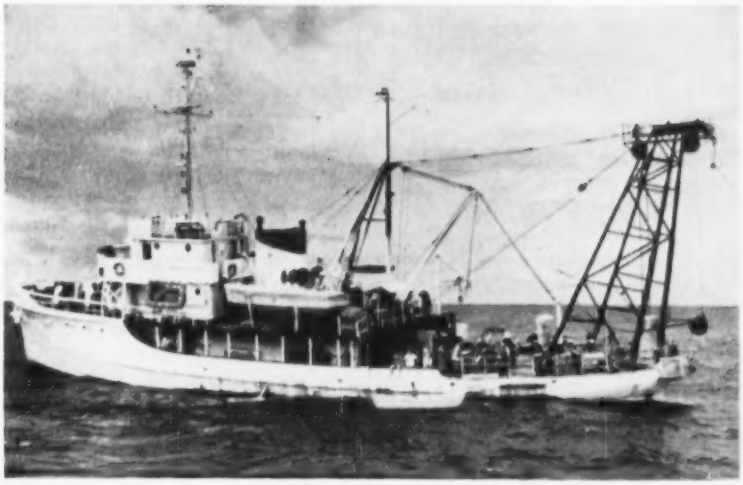
In the block diagram of Fig. 1, frequency variation of a thermistor Wien-bridge oscillator is used to measure temperature. Depth information is provided by monitoring the frequency change of a vibrating wire connected to a flexible diaphragm. Both signals are sent over a single conductor to the ship where they are separated by high-pass and low-pass filters for recording.

Depth Measurement

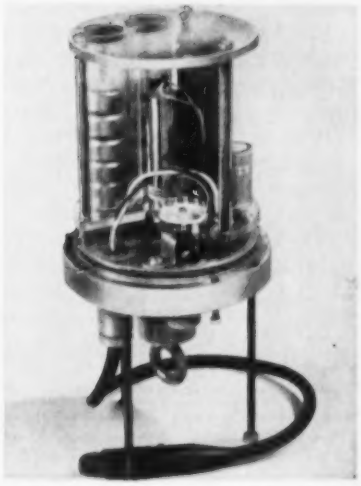
A Vibrotron is a vibrating-wire transducer in which a mechanical displacement is converted into a frequency change of a vibrating wire. The wire is connected at one end to a pressure-sensing diaphragm. A displacement of the diaphragm changes the tension in the wire thus changing the frequency of vibration. Frequency range of the unit used in this equipment is approximately 9,600 to 11,240 cps.

Electrically, the vibrating wire is similar to an electrically driven tuning fork. The wire is of nonmagnetic material and is placed in a fixed magnetic field at right angles to the axis of the wire. When the wire vibrates at its natural frequency, it becomes an a-c generator, generating a voltage that can be amplified by conventional means. If some of the amplified voltage is fed back to the ends of the wire in phase with the generated voltage, vibration is sustained.

An agc circuit is added to the amplifier to control the amplitude of vibration. The output frequency of the system is a pure sine wave, controlled by the axial displacement of the wire. The output frequency is thus nearly a linear function of the pressure applied to the pressure-sensing diaphragm.



Research ship equipped with boom for raising and lowering bathythermometer to measure temperature gradient of ocean water



Depth sensing unit with cover removed to show vibrating-wire transducer (center)

Telemeters Ocean Data

Figure 2 illustrates the circuitry for the three-stage transistor amplifier used with the vibrating wire transducer. Because the vibrating wire and static wire impedances are relatively low, a step-up transformer is utilized. The grounded-emitter first stage is resistance-capacitance coupled to the grounded-emitter second stage, which in turn, is directly coupled to the grounded-collector output stage. A properly phased positive-feedback loop is fed from the low-impedance emitter of Q_3 to the center-tap of two resistances bridged across the primary of the input transformer.

An automatic-gain-control network is necessary to drive the Vibratron at constant amplitude. Because the relationship between amplitude and frequency of vibration is exponential, it is necessary to maintain the amplitude constant for a given stability. A voltage of between one and two millivolts measured across the vibrating wire is considered satisfactory.

Under the operating conditions chosen, gain of the first grounded-emitter stage is essentially dependent upon the value of r_e. If I_e is varied over a range of 75 to 20μa, the graph of Fig. 3A shows the variation in voltage gain of the first stage versus input voltage. The measured value of r_e at one milliampere for the type 202 transistor used is 33 ohms. The variation in the measured and computed values results in part from assumptions made in deriving the equation for voltage gain.

The graph of Fig. 3B plots output voltage as a function of input voltage for the three-stage amplifier. Also plotted is emitter current of the first stage as a function of input voltage. The overall result of the automatic gain control action is less than ½-db change in output voltage for a 3-db change in the input voltage at values over one millivolt input.

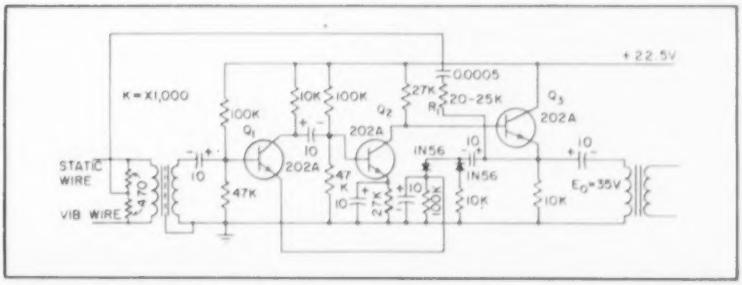


FIG. 2—Transistor amplifier for vibrating wire transducer uses agc to maintain output level at constant amplitude

Temperature Stability

The temperature stability of the amplifier is considered adequate for this application. Sea-water temperature generally is found in the range of 0 to 28 C. Bias stabilization is generally established by the large emitter resistors and the voltage dividers in the base circuits of the first two stages. The degree of temperature stability was measured in actual tests from 5 to 55 C. Fig. 3C shows the results of out-

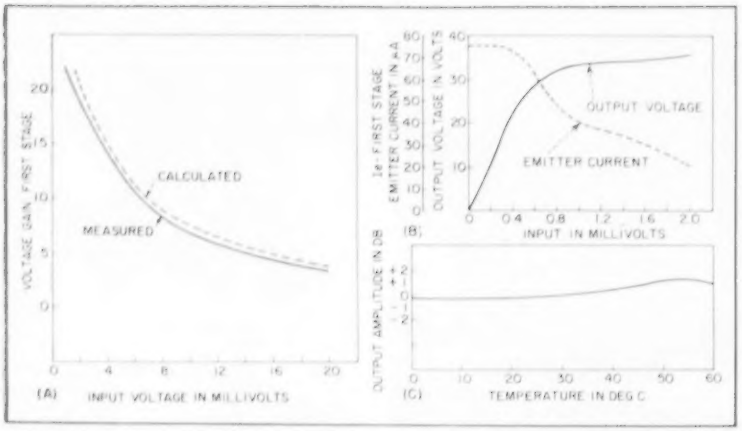


FIG. 3—First stage gain (A), output and agc response (B) and frequency response curve (C) for transistor amplifier used for depth measurement

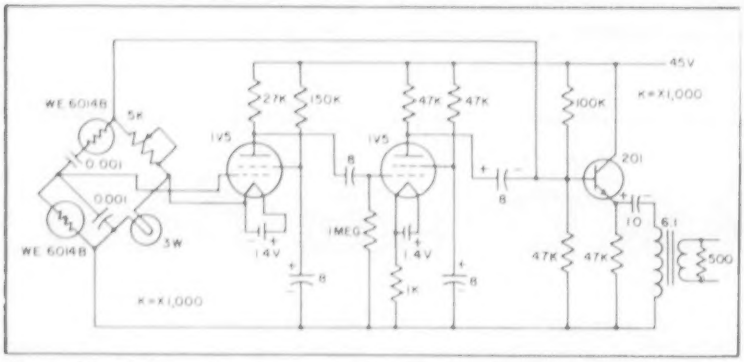


FIG. 4—Wien bridge oscillator circuit used to measure water temperature. Units encapsulated in epoxy resin and sealed in pressure tight housing.

put voltage against temperature. Only minor distortion was noticed over this range.

The output voltage is approximately 0.5 volt when working into a loaded 500-ohm line.

Temperature Sensing Circuits

The temperature sensitive oscillator is of the Wien bridge type, with 6014A thermistors as resistive elements in the reactive arms of the bridge. This type oscillator was chosen because of its simplicity and dependable performance. Its one disadvantage is that separate filament batteries are necessary when using filament type tubes. The circuit is shown in Fig. 4.

The bridge balance and oscillator frequency is set by

$$R_1 = 2r$$

$$f_o = \frac{1.59 \times 10^4}{\sqrt{C^2R^2}}$$

where f_o = frequency of oscillation, R_1 = negative feedback resistor, r = lamp resistance, R = thermistor resistance and C = capacitance in each half of positive feedback arm.

The temperature coefficient of resistance for the thermistor chosen is −3.9 percent per deg C. Unfortunately, the resistance versus temperature characteristic is nonlinear as shown by the following equation:

$$R = R_o e \exp B[(1/T) - (1/T_o)]$$

where R_o is resistance at reference temperature in deg K, and B is a constant dependent on thermistor material.

When the resistance of the reactive arms is allowed to vary according to this relationship, the frequency-temperature graph of Fig. 5 is formed. An average sensitivity of about 40 cps per deg C is established.

Battery Supply

The tubes chosen use 40-ma filaments, making economic battery operation feasible. The grounded-collector transistor output stage serves to isolate the output circuit from the oscillator section. An output voltage of 0.5 volt is available when loaded by a 500-ohm line.

The temperature stability of this oscillator is satisfactory for this application. When properly adjusted, a frequency variation of one to two cps over an eight-hour period at constant temperature is normal.

Over a temperature range of 5 to 50 C, a frequency change of four to five cps was observed in laboratory tests.

Speed of response is important since the instrument is lowered and raised through the water at a rate of 2.5 feet per second. A thermal time constant of one second or less is necessary to resolve all the detail present. A step-function change in temperature will result in a frequency equilibrium within two seconds in sea water. This time has been cut to the order of one second on occasion by grinding down the glass surface of the thermistor beads.

Instrument Housings

Both the pressure sensitive transistor amplifier and the temperature sensitive oscillator are encapsulated in a silica-filled epoxy resin. Plug-in construction is used to simplify

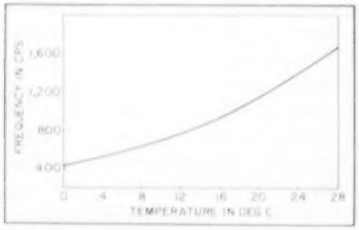


FIG. 5—Plot of oscillator frequency variation with temperature

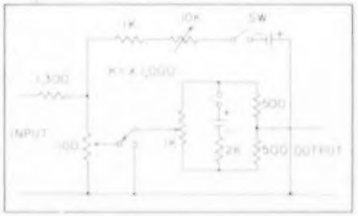


FIG. 6—Zero set circuit used with recorder. Variable resistor and potentiometer are helical type

maintenance and construction.

The instrument is divided into pressure and temperature units and individually housed so that they might be used separately if desired.

The cases are of 5 in. inside diameter, 0.312 in. stainless steel tube. The end plates are of 1-in. brass with O-ring pressure seals. Packing glands are used pass the instrument leads to the surface.

The two instrument housings are pressure tight and designed for a maximum pressure of 5,000 lb per sq in., with an adequate safety factor.

The outputs of the pressure and temperature units are coupled on one side to the instrument case and the other to a single-wire polyethylene-insulated cable. The cable is a 19-strand steel wire with a tensile strength of about 2,800 pounds. The polyethylene jacket brings the overall diameter of the cable to approximately 0.32 inch. The polyethylene jacket also performs the extremely important job of giving the cable buoyancy. This allows the cable to support much greater instrument loads at greater depths, since the cable itself is almost weightless in sea-water.

At the surface the signal is taken off the research vessel's winch via slip-rings. A sea return to the instrument is used with a zinc plate serving as the ground-return connection.

Surface Instrumentation

Surface instrumentation, as shown by the block diagram, consists of a broad-band amplifier capable of handling frequencies up to 15 kc. The frequencies are then separated by a high-pass and a low-pass filter and passed to a demodulator. The resulting d-c outputs are functions of pressure and temperature.

To make these parameters suitable for recording on an X-Y function plotter, a circuit to set zero bias and scale factor is a necessity. It is shown in Fig. 6. This zero offset method is used to set at center scale on the recorder the midrange of both the temperature and pressure functions.

Pressure signal is applied to the X-axis and temperature signal to the Y-axis. This makes it possible to roll the chart manually after each successive run, thus completing a family of bathythermometer curves.

The two channels are also recorded on magnetic tape. A dual channel recorder is used with the combined temperature and pressure information recorded on one channel and a constant 5,000-cps signal on the other. The advantages of this type data storage and playback are self-evident and work is being continued to perfect this phase of the instrumentation problem.

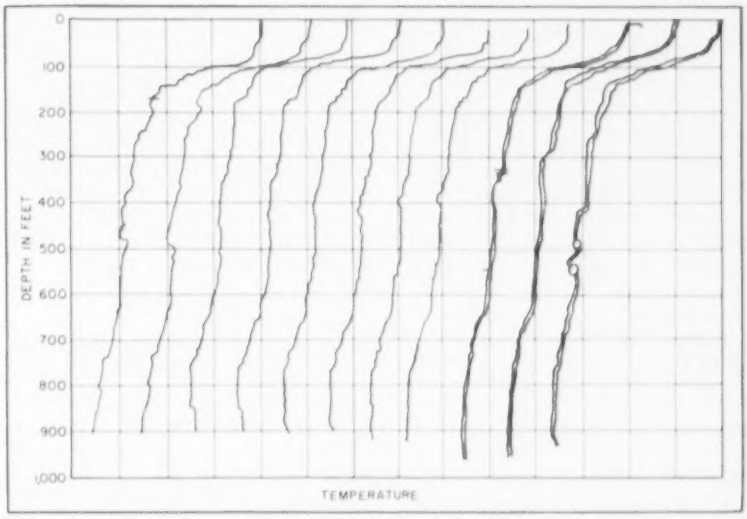


FIG. 7—Typical family of temperature-depth curves obtained with bathythermometer off the coast of San Diego, California

Test Results

This instrument has been used at sea with good results. Fig. 7 is a continuous bathythermometer plot taken at sea off San Diego, California. The research vessel was drifting very slowly. Over the narrow range covered, the temperature scale is nearly linear. Small positive and negative temperature gradients are readily apparent and possible sound channels are indicated.

The vibrating-wire transducer has an absolute resolution of approximately 0.003 inch at the 2.5 ft lowering rate generally used. The overall system is limited by the time constant of the frequency meter. The resulting resolution of the overall depth-measuring system is therefore of the order of 0.3 inch. Absolute accuracy in depth is better than ±0.25 percent or ±2.5 ft in 1,000.

The temperature sensitivity is approximately 40 cps per deg. C. When these parameters are converted to direct current and applied to the function plotter with a ten-inch chart width, a depth variation of ±2.5 ft per 1,000 can easily be read. If ten degrees of temperature are applied to ten inches of chart, a temperature variation of 0.050 deg C can be accurately plotted.

Reproduction of pressure and temperature plots takes place without significant hysteresis effects. This was checked while at sea, where surface temperature and pressure can be accurately measured.

This work was carried out at the Special Developments Division of the Scripps Institution of Oceanography and was supported by funds from the Office of Naval Research and the Bureau of Ships, United States Navy. The authors extend their gratitude to all who took part in this problem, and in particularly to G. T. Barlow and R. M. Blei for their help and assistance in the construction of the equipment.

Simultaneous Color-TV

SUMMARY —— Differential gain, phase characteristic, flag burst and chroma amplitudes can be determined on monitors or home receivers using test signal that is transmitted simultaneous with program. Waveforms occupy three horizontal lines, one line displaced above top of picture

FOR several years there has been need for some type of information that can be transmitted during a television program to establish levels of sync, setup and peak white. With the introduction of color broadcasting, there has developed the necessity for determining differential gain and phase characteristics of the system as well as the amplitude of flag burst and chroma.

Considerable progress has been made by the use of such signals as windows, stairsteps, multiburst and variable-duty-cycle bars. These may be transmitted during the station breaks and provide much valuable information concerning system performance. Since tney do not appear during program transmission time, it is impossible to appraise the performance of a system while it is in use.

Picture Quality

Departures from normal, either steady state or transient, can not be apprehended until the system has degenerated to the extent of causing noticeable impairment of picture quality. The extent of such impairment may produce only slight picture degradation or it may ruin the picture completely. Needed is a signal that may be transmitted concurrently with the television program, one that does not produce adverse effects upon the picture and yet is of such nature as to suffer the same distortions as the picture. The signal to be described

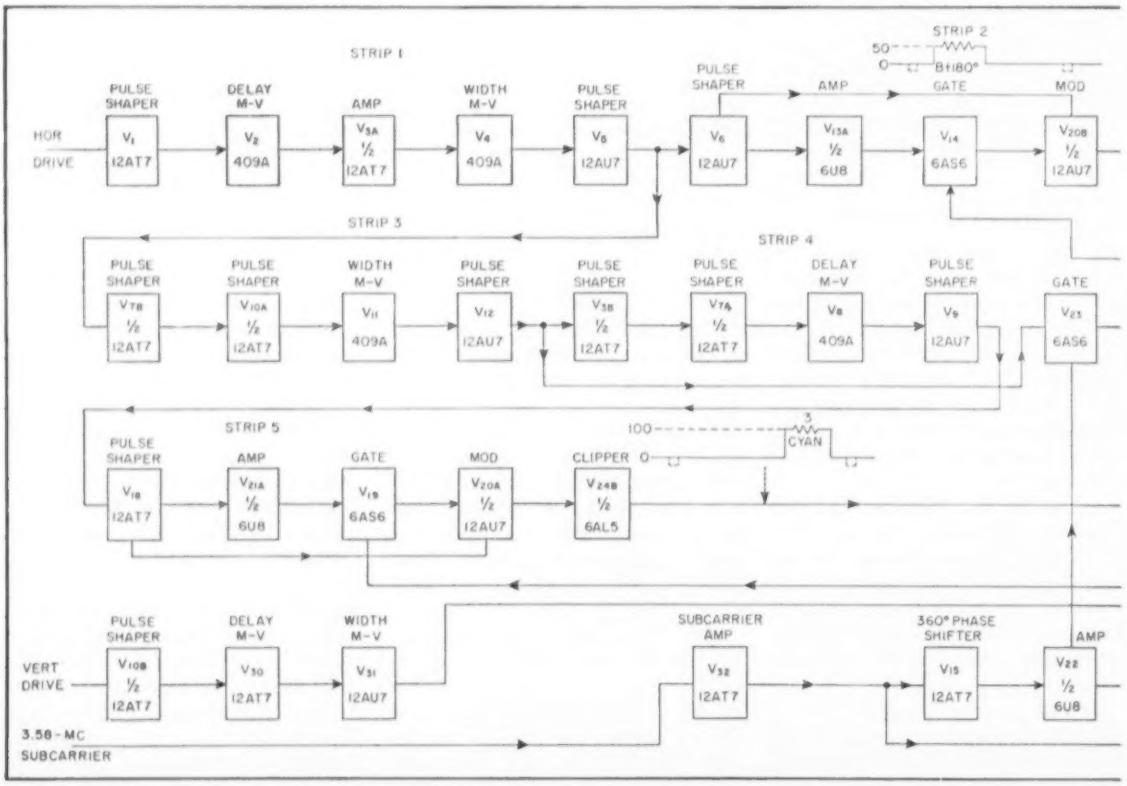


FIG. 3—Block diagram of the complete test signal equipment

TEST SIGNAL

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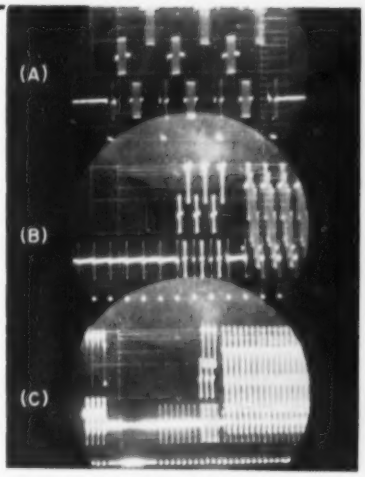

FIG. 1—Test signal for three sweep speeds. Signal appears after second set of equalizing pulses (A) in vertical blanks

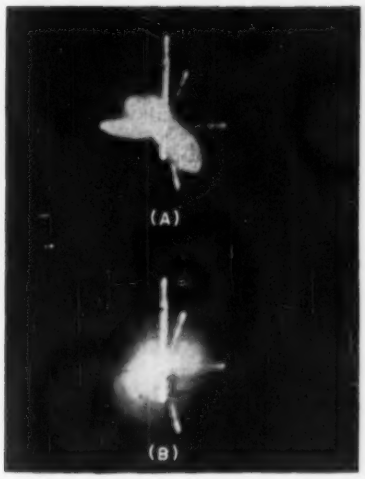

FIG. 2—Signal inserted in color program (A). Test signal inserted in monochrome program (B) shows no flag burst

meets all the above requirements.

Figure 1 shows the test signal for three different oscilloscope sweep times. In Fig. 1A, the signal appears after the second set of equalizing pulses during the vertical blanking time. The signal, which occupies three horizontal lines, is located close to the top of the picture. As shown in Fig. 1B and 1C, only one inactive line separates the test signal and the top of the picture.

This location has been found essential. If the signal appears earlier in the blanking interval, some receivers and monitors show retrace lines where the half-white and white bars appear.

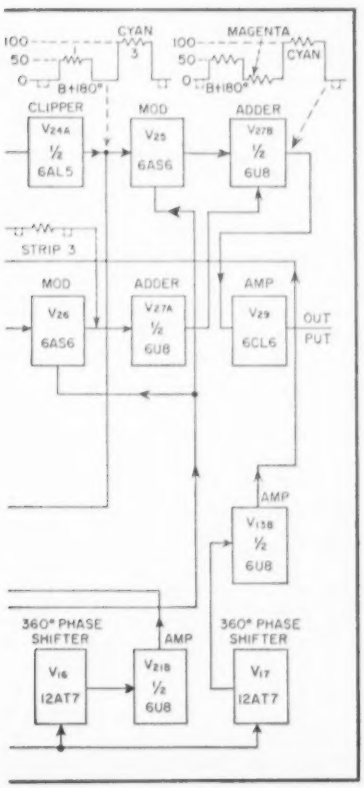

Figure 1 also shows that each of the three lines is the same and consists essentially of three pedestals having amplitudes of 50, 0 and 100 units respectively on the IRE scale corresponding to half white, sync and white.

Starting with sync and proceeding from left to right, there are the usual breeze-way, color-flag-burst and back-porch intervals. About 1 μsec after the color flag burst, there appears 20 μsec of half-white amplitude bar having a rise time of 0.1 μsec. Centered and superimposed on this bar is 10 μsec of 3.579-mc sine-wave phased 180 deg from the flag burst.

This bar is followed by 2 μsec of sync pedestal after which appears 10 μsec of 3.579-mc sine-wave phased to magenta and superimposed on the pedestal.

Two microseconds of sync pedestal separates the magenta sine-wave and the next bar. This has a duration of 20 μsec and an amplitude of 100 IRE units, which corresponds to white. The rise time of this bar is 0.1 μsec. Centered on this bar is 10 μsec of 3.579 mc sine wave phased to cyan. The sine waves are depressed into the pedestal so that the positive crests correspond to 100 IRE units. This is done so as to have no part of the signal exceed white level, which represents the maximum acceptible negative modulation level for the transmitter.

The amplitudes of the three sine-wave portions are 40 IRE units, peak-to-peak. The a-c axis of the cyan data is therefore at 80 IRE units.

Choice of Signal

It is well to consider various aspects of the signal and the conclusions that lead to the present wave form. Initially, it was desired to create a signal indicating the proper values for white level, chroma and burst amplitudes. Transmission of white level alone has no meaning if nonlinearities exist anywhere in the system since stretching or clipping of the white bar will not reveal the amount of departure from the original.

The half-amplitude bar is used to establish all other levels. It is assumed that this bar can be sent undistorted through the circuit under test. Since it closely approx-

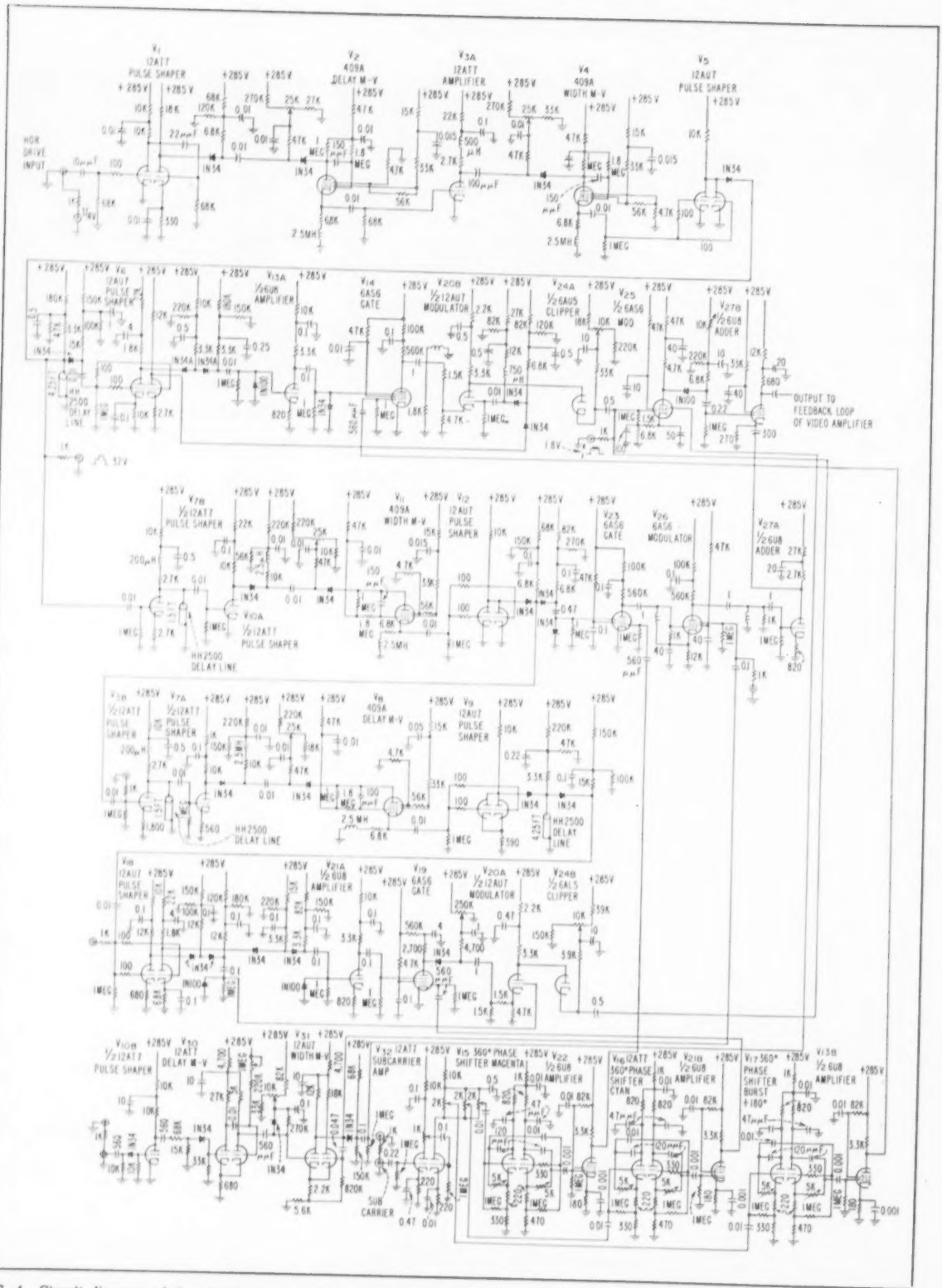

FIG. 4—Circuit diagram of the simultaneous color test signal generator

imates the a-c axis of the signal, it should suffer a minimum of distortion in transmission.

The white bar has twice the amplitude of the half-amplitude bar and any stretching or compressing of white is easily detected from the ratio of the two amplitudes that can be quickly determined.

Placing the two bars at the left and right of the screen is desirable to reduce halation in the top center of the picture. The three sine-wave signals placed on the pedestals makes possible the evaluation of the differential gain and phase distortion.

The choice of burst + 180 deg for one of the sine-wave phases was made for two reasons. It is easy to see if it is properly adjusted when viewed on a vectorscope since it and the flag burst vector should form a straight line. It also provides a ready reference when used with a monochrome signal that has no flag burst.

Color Choice

Since the eye is most sensitive to cyan and magenta hue variations, it was decided to use these two phases for the other sine-wave signals. There appears to be some possibility that these colors may aid in adjusting receivers and monitors.

The amplitudes of the three sine waves are made identical to aid in measuring differential gain distortion. The flag burst and the three sine-wave signals should have the same amplitude and lie on the same axis when the signal is passed through a high-pass filter having a 1-mc cutoff frequency. Departures from this condition are caused by differential gain distortion.

When a color program containing the test signal is viewed on a vectorscope, the three sine waves produce vectors that are quite apparent. These change their positions when they are passed through a system having differential phase distortion. The amount of distortion can be read to one degree on a vectorscope.

The 10-μsec duration of the sine-wave signals may seem long. However, severe distortion of the flag burst may occur owing to bandwith limitations in the transmission system. This effect has been termed footballing from the shape of the flag burst suffering this distortion. For large distortions of this type, it is impossible to tell what the received amplitude of flag burst really should be. The 10 μsec of sine wave is long enough to permit several cycles having the same amplitude to appear in the middle of the interval even for gross bandwidth limitations.

Pedestal Signals

The pedestals are made longer in time than their associated sine waves for several reasons. Compression or clipping of white level will cause the a-c axis of the sine wave to be bowed. The amount of bowing can be compared to the pedestal.

The pedestal also shows a rounded shape on the leading edge (integration) or a spike (differentiation) when the low-frequency (15 kc to a few-hundred kilocycles) region suffers phase-vs-frequency distortion. This form of distortion is evident as a tilt in the pedestal or smear in the picture. It also causes an apparent loss in resolution. Hence, it is possible with the test signal to appraise the low-frequency transient conditions in the system.

Measurements

In addition to the data available in an oscilloscope presentation as is shown in Fig. 1, there are also those obtained from a vectorscope screen such as is found in Fig. 2A and 2B. In Fig. 2A, the signal is inserted in a color program. The flag burst vector appears as a horizontal line to the left of the origin. The vector representing the sine wave in the test signal phased 180 deg away from the flag burst is apparent as a horizontal line to the right of the origin. The magenta vector is about 120 deg clockwise from the flag burst while the cyan vector is 103 deg counterclockwise from the flag burst.

Figure 2B shows the test signal inserted in a monochrome program. Since no flag burst is present, the vector to the left of the origin is missing. However, the three vectors representing burst + 180 deg, magenta and cyan are clearly presented. This indicates the possible utility of the signal on testing a monochrome circuit prior to its being used for color by the broadcaster.

The signal has been used on the air for a number of months following FCC authorization. No adverse affects have been noted either in monitors or receivers. It has materially aided in making various adjustments necessary for color transmissions.

Generator

Figure 3 is a block diagram while Fig. 4 is the complete circuit diagram of the generator. Development of the complete waveform requires four phantastrons used as multivibrators and four open-circuit delay lines to control pulse width. Three phase shifters control the phases of the three sine-wave signals. These are continuously variable through 360 deg.

Two multivibrators are used to establish the number and location of the lines comprising the signal in the vertical blanking interval. The signal is added on the feedback loop of a line amplifier connected in cascade with the Y channel delay line of the colorplexer.

The half-white and white pedestals are combined and clipped at horizontal line rate after which they are gated at the vertical rate. The magenta pedestal is gated at horizontal line rate, reduced to an a-c axis signal and then gated at vertical rate. The two parts of the signal are combined at this time. This procedure is used to permit clipping of the half-white and white pedestals, which adjusts their amplitudes, without clipping the magenta sine wave.

The author is indebted to A. L. Hammerschmidt, Vice President and Chief Engineer of the National Broadcasting Company and Howard C. Gronberg of the NBC Engineering Department for valuable suggestions and encouragement given during the course of this investigation.

COUNTER CIRCUITS

By E. F. WELLER, Jr., N. W. SCHUBRING and M. E. FITCH*

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SUMMARY —— Peak pressure distribution counter quantizes a sixty-degree sector of crank angle into three-degree intervals or channels to study ignition characteristics of various fuels for auto engines. Two-decade counter in each channel is gated by 21-stage ring counter to register possible pulses occurring at time of peak compression pressure. Equipment uses plug-in subassemblies wherever possible

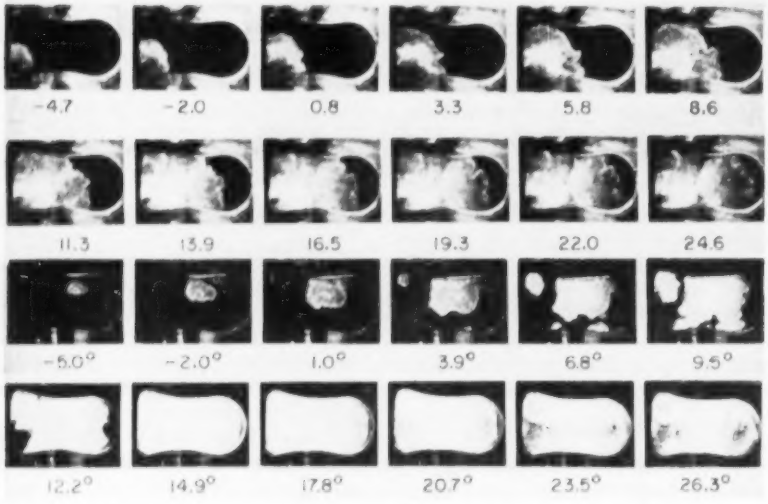

FIG. 1—Part of normal combustion sequence (upper two rows) as viewed through a quartz-headed engine and complex pattern resulting from particle-induced ignition (bottom rows). Numbers represent crank-angle position in degrees during power stroke

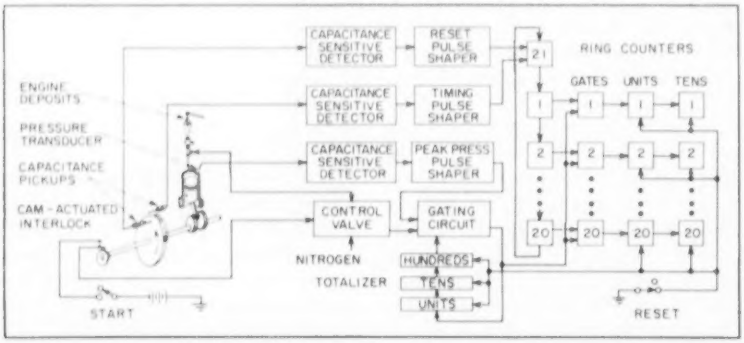

FIG. 2—Block diagram shows how crank angle is quantized into 20 channels that register distribution of peak pressure pulses occurring during ignition

PARTICLE-INDUCED IGNITION has received considerable attention in the past few years., It may be detected by engine roughness caused by wild ping, preignition or postignition. Recent studies indicate that use of higher compression ratios in the near future may be limited by this phenomena rather than by fuel octane requirements.

A number of methods[2, 3, 4, 5, 6] have been proposed for measuring and evaluating particle ignition, but these methods give qualitative rather than quantitative results. This article discusses an instrument developed to provide a rapid and accurate method of rating fuels.

Combustion

Under normal operating conditions, the engine cylinder combustion processes proceed as a smooth-burning flame front. Particle ignition, on the other hand, causes erratic fuel burning, resulting in preignition, etc. In Fig. 1, two different types of combustion are shown, for normal operation and for particle ignition.

The method for rating fuels consists of determining the difference in position of peak pressure for

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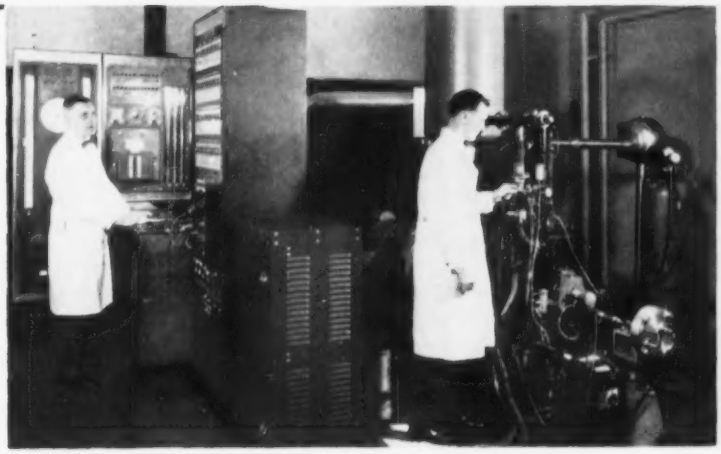
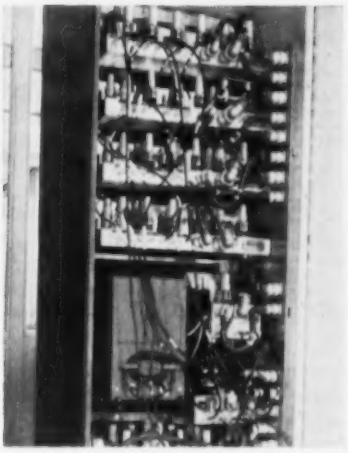
This article is based on a paper presented at *NEC*, Oct. 1956 and appearing in Vol. 12, *Proc NEC*.

ANALYZE IGNITION



Information obtained from peak pressure distribution counter on racks at left, used with single-cylinder test engine at right, enables engineers to determine particle ignition characteristics of many fuels in a relatively short period of time



Extensive use of plug-in subassemblies is evident in this view of the counter. Duct at right distributes power to assemblies

normal and particle ignition when similarly compared to reference fuels. Particle ignition is produced by injecting a known weight of engine deposits into the chamber for both the reference and test fuels.

Because of engine cyclic variations in air-fuel ratio, etc, the peak pressure does not occur at a specific crank angle, but over a band of crank angles.

The deposit ignition peak pressures are scattered over a wider band caused by variation in deposit concentration in addition to cyclic variations. It is therefore, necessary to obtain sufficient data to be able to determine the average peak pressure from the normal and deposit-ignited engine cycles.

Originally a film technique using double-beam oscilloscope traces was employed. The data reduction time for such a method became prohibitive when many fuels were to be tested.

The instrumentation developed to aid in this test work quantizes a 60-deg sector of crank angle into 3-deg increments or channels covering the portion of the engine cycle wherein the distribution occurs. Ideally it is desirable to have an infinite number of channels. This is not practical, however, and the 20 channels in the peak pressure distribution counter have been shown to produce sufficiently accurate data to rate fuels closely.

Peak Pressure Counter

A simplified block diagram of the counter is shown in Fig. 2. A timing wheel, connected to the crank shaft, synchronizes the operation with the engine under test. Capacitance-displacement pickups are located to detect the proximity of projections on the wheel. The detected changes in capacitance are converted to electrical signals by two capacitance-sensitive detectors.[7] The signals from these detectors are fed to pulse-shaping amplifiers where they are sharpened to operate and synchronize a 21-stage ring-counter circuit.

The engine pressure is detected by a capacitor-type engine pressure transducer[8] that feeds a Capacagage unit to provide an electrical equivalence of pressure variations. This provides the input to the peak pressure circuit. High-frequency hash, such as that due to engine knock, is removed by a low-pass filter to provide electrical signals corresponding to typical pressure. The filter was designed to preserve the basic waveform by making the phase shift a linear function of frequency over the desired range. Thus, a constant delay is introduced, but one which may be readily compensated.

The instrument can be started at any point in the engine cycle when obtaining a normal distribution. However, when testing for the effects of particle-induced ignition it is necessary to actuate the counter by a cam, turning at camshaft speed, that permits the control valve to operate only during the low-pressure portion of the engine cycle prior to the compression

The deposits are injected into

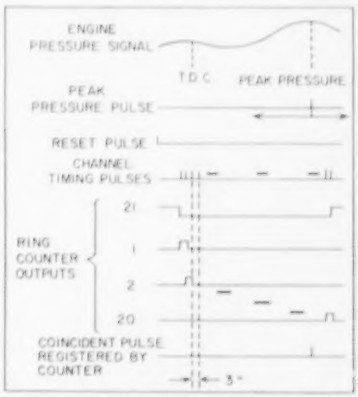


FIG. 3—Simplified timing chart. Pulse generated at peak pressure is gated through synchronized ring counter. Decade counters register coincidence between peak pressure and an open ring stage

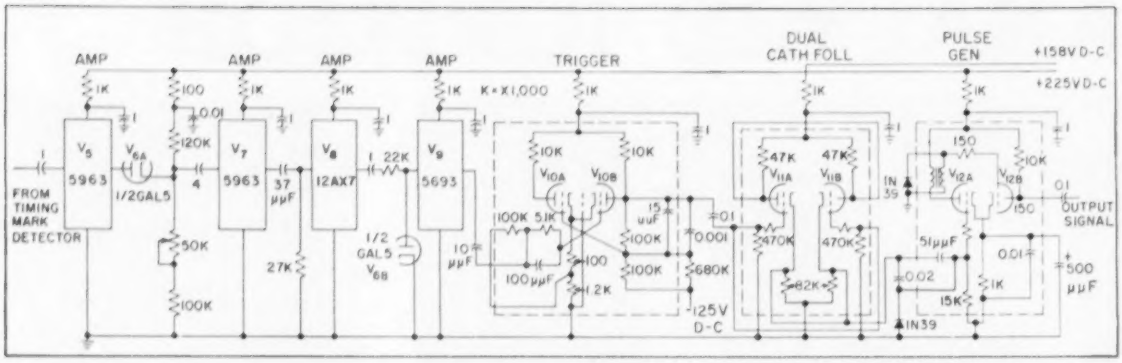


FIG. 4—Timing-pulse circuit. Negative pulses at 3-degree intervals are generated from capacitance variations between timing wheel and displacement pickup that are amplified and shaped to trigger the blocking oscillator output stage

the combustion chamber by high-pressure nitrogen. When the valve opens, a signal is transmitted to the gating circuit, opening the gate and permitting the peak-pressure pulses to pass on to the totalizer and coincidence gates. Operation of the counter is more easily understood by referring to the timing diagram in Fig. 3.

Reset Pulse

The reset pulse occurs once per engine revolution and synchronizes the ring counter prior to the operation of the ring by the timing pulses. The Capacagage signal, an electrical analog of the capacitance variation between the displacement pickup and a stud in the timing wheel, is fed to a twin-triode amplifier. The output from this stage is differentiated and the negative portion removed by diode clipping. A small capacitor across the output of a second amplifier filters the output and helps prevent oscillations which tend to be generated in this stage.

At this point the signal level is sufficient but of the wrong polarity. The first section of the next amplifier inverts the signal to drive a pulse amplifier. The output from the pulse amplifier is a 150-v negative pulse with a duration of 90 μsec.

Timing Pulses

Timing pulses are also generated from the timing wheel with a Capacagage and displacement transducer. There are 21 of these pulses separated by 3-deg increments that can be adjusted to occur anywhere in the engine cycle by angularly shifting the wheel with respect to the pickup. The wheel is located so that channel 1 begins at or near top dead center. The circuit for the timing pulses is shown in Fig. 4. The detector output is fed to amplifier V_9 and then through diode clipper V_{9d}. Only the signal variations which occur on top of the signal pedestal are desired, to amplify the entire signal in V_7 would result in blocking this amplifier. The output from V_7 is differentiated, amplified in V_8 and clipped by V_{8d}. The signal at this point is negative and is used to drive amplifier V_9. The output of V_9 is differentiated and drives trigger V_{10}.

To obtain sufficient drive for blocking oscillator V_{12} it was necessary to use cathode follower stage V_{11}. The output of the blocking oscillator is a negative 1.5-μsec pulse, 120 volts in amplitude.

Peak Pressure Circuit

Low-frequency amplifier V_{13} shown in Fig. 5, amplifies and inverts the signal, after which it is fed to a clipper having an adjustable clipping level. The clipping level is normally set to pass the por-

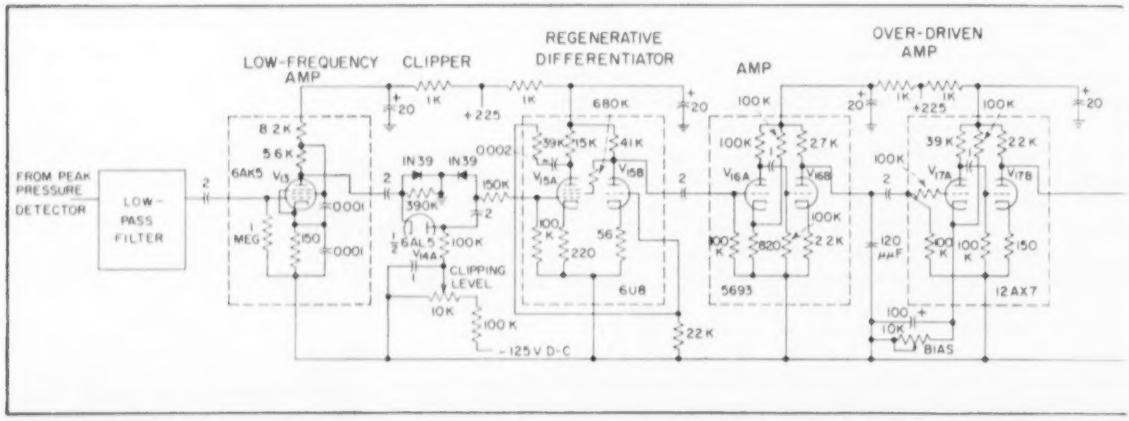


FIG. 5—Capacitor-type transducer detects cylinder pressure variation to drive peak pressure pulse circuit to produce output pulse

tion of the signal corresponding to all pressures just above the compression pressure at top dead center. The resulting signal has a flat baseline and only one other position of zero slope and thus lends itself to differentiation to provide a baseline crossing point at the time corresponding to peak pressure. Since the clipped signals assume a variety of waveshapes and have a wide dynamic amplitude range, regenerative differentiator V_{15} was developed

The differentiated signal from V_{15} which crosses the baseline at the peak pressure time is amplified by V_{16}. The 120-$\mu\mu$f capacitor from output to ground prevents oscillation. Stage V_{17} is an overdriven amplifier normally biased near cutoff to provide a signal approaching a rectangular pulse. The leading edge corresponds to time of peak pressure. This signal is differentiated and the negative spike is removed by clipping the stage V_{18A}. The positive spike triggers one-shot multivibrator V_{19} to provide a 16-millisec rectangular pulse. This insures that any retriggering resulting from oscillation in the amplifiers is precluded and a spurious peak-pressure pulse cannot occur until the active channels have been passed.

To supply the proper waveform to trigger the counters, the 16-millisec rectangular pulse is again differentiated and the leading spike made to trigger one-shot multivibrator V_{19}. The output rectangular pulse width of V_{19} is normally set to 20 μ sec by the pulse width control. This pulse is inverted by V_{20A} and applied to cathode-follower V_{20B} where the impedance is transformed to a value sufficiently low to drive the connecting coaxial cables.

Ring, Gate and Counter

The reset pulse and timing pulses control a 21-stage ring counter or electronic commutator. The channel decade counters and the coincidence gates register a count when coincidence exists between an active channel and a peak pressure pulse. The peak pressure pulses at this point have been gated and inverted by the control circuit to permit counting during a specified interval.

Each counter stage is essentially an Eccles-Jordan circuit. The cathodes of all left sections in each stage are tied to a common 1,000-ohm potentiometer while the cathodes of the right sections are tied to a common 20,000-ohm potentiometer. When these common cathode resistors are adjusted to have a ratio of approximately 1 to 20, the quiescent state will be such that 20 of the left sections of the 21 stages will be conducting while the right section of the remaining stage must be conducting to end up with equal cathode potentials. The negative timing pulses are applied to all of the left-section cathodes simultaneously. The one stage in which the left section had not been conducting will be forced into conduction by the negative timing pulse. Each successive timing pulse indexes the ring one step forward.

Orientation of the ring is assured by a reset pulse which conditions the ring such that the first channel gate from the ring in each cycle is generated by the first stage.

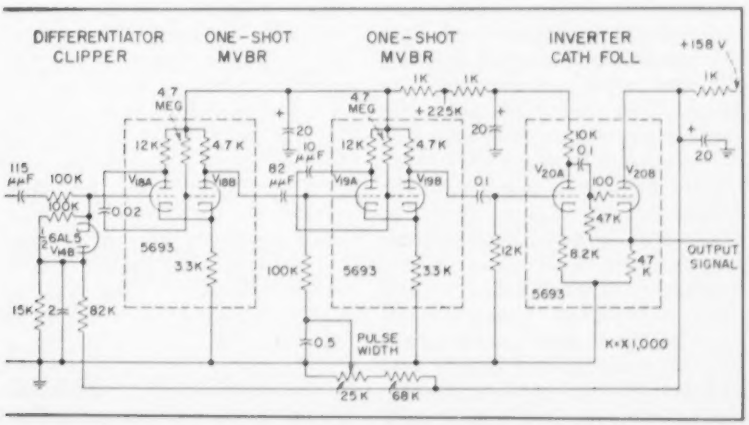
The successive positive gates from ring stages 1 through 20 are each applied to one control grid of separate coincidence gate stages for each of the 20 channels. The other control grids of each of the 20 coincidence gate stages are connected in common and are fed the positive-gated peak pressure pulse. When the gated peak pressure pulse is coincident with the positive gate from a ring stage the coincidence-gate stage conducts, giving a negative signal. This negative pulse is reinverted and amplified and subsequently fed to the units decade counter* for that channel. When the units counter completes the registration of a decade, a count is transmitted to the tens counter. In this way a total of 99 counts per channel is possible.

Control and Totalizing

The control and totalizer circuits shown in Fig. 6 initiate and terminate the active counting period. Opening the reset bus resets all counters including the totalizer to zero. When the total number of peak pressure pulses reaches the preset value of the totalizer counter the counting stops.

Thyratron V_{19B} energizes the solenoid control valve, permitting injection of powdered engine deposits into the combustion chamber. The thyratron firing time is interlocked by cam-actuated contacts on the engine to insure injection during the intake stroke only, thus precluding the possibility of backfire through the injection valve. The control grid of V_{19B} normally has a fixed negative bias. Pressing the start button energizes the relay, provided that the interlock is open. If the interlock happens to be closed at that instant, the relay is short-circuited through its normally closed contact but as soon as the interlock breaks, the relay energizes.

The next time that the engine-driven interlock closes, the grid of V_{19B} is grounded through a 10,000-ohm resistor, overcoming



that is normally set to 20 μsec by the pulse width control

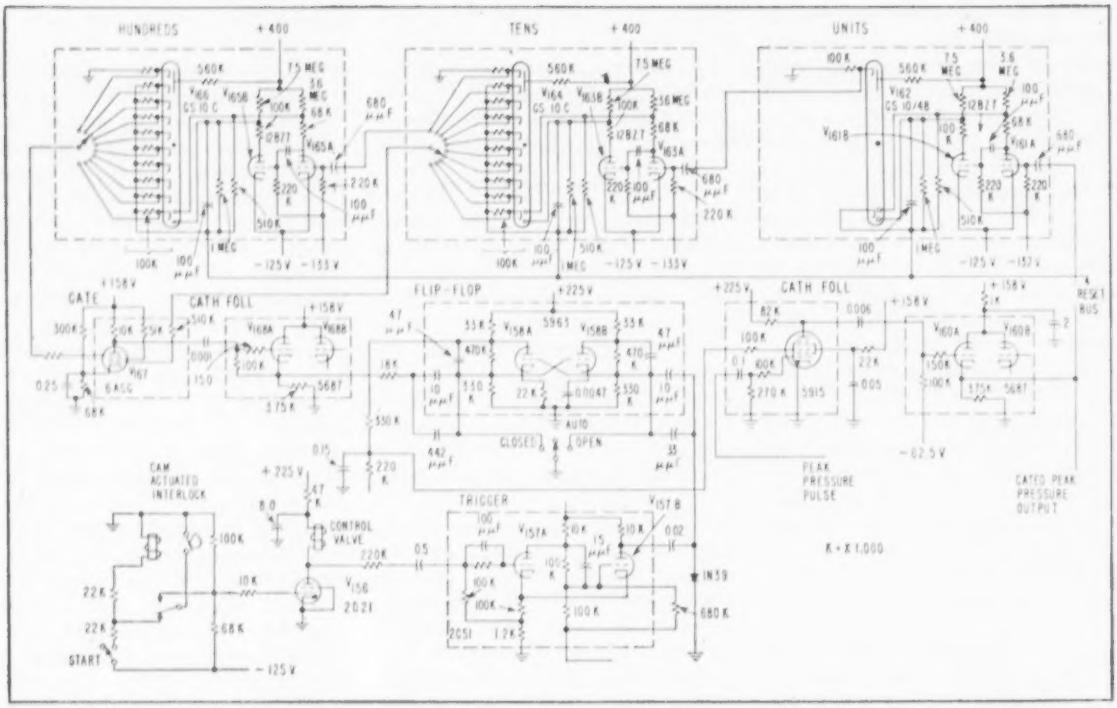


FIG. 6—Control and totalizer circuits show how peak pressure pulses are gated when particle control valve is actuated. Output is obtained when three-decade totalizer counter reaches its preset value which may be any multiple of 10 up to 10,000

the bias, and the thyratron fires. The injection-valve solenoid in the plate circuit is energized, permitting compressed nitrogen to blow deposits into the combustion chamber. The grid of the thyratron is grounded once every engine cycle until the start button is released but the 47,000-ohm and 8μf time constant in the B supply to the thyratron insures that the valve is energized only once.

The negative signal taken from the plate of the thyratron is squared by trigger V_{157}, differentiated and clipped, and the negative pulse at the leading edge applied to one input of flip-flop V_{158}. If selector switch S_1 is in the normal automatic position, V_{158A} is initially conducting. The negative pulse from trigger V_{157} cuts off V_{158A} and its plate goes positive. This positive signal is applied to coincidence gate V_{159}. Both control grids of V_{159} are now in position for V_{159} to conduct. The negative peak pressure pulses applied to the control grid result in positive pulses at the plate of V_{159} as long as the flip-flop maintains conduction in V_{158B}. The gated peak pressure pulses taken from the plate of V_{159} are strengthened by cathode follower V_{160A} and applied to the ring, gate and counter circuits.

Simultaneously, the gated peak pressure pulses are fed to the 3-decade preset totalizer counter. The totalizer may be preset to any multiple of 10 up to 1,000 since only the tens and hundreds decades may be preset. Upon reaching preset, simultaneous positive voltages are delivered to coincidence gate V_{167} by both the tens and hundreds decade. When this occurs, a negative-going output taken from V_{167} is strengthened by cathode follower V_{168A} and applied to flip-flop V_{158}. The cathode follower is employed because the totalizer and gate V_{167} are on another chassis remote from that of the rest of the circuit of Fig. 7.

The negative pulse from cathode follower V_{168A} causes V_{158B} of the flip-flop to cut off and V_{158A} to conduct. When V_{158A} conducts, the negative-going plate closes gate V_{159} and peak pressure pulses are no longer passed. In operation, the channel counter readings would now be recorded and the reset button pushed to prepare for another run.

A manual peak pressure gate is provided by selector switch S_1. This may be used to start or stop counting. Thanks are due to F. W. Bowditch and R. Stebar for many helpful consultations and to E. A. Hanysz, W. Colcer and H. McClow for designing and assembling certain components.

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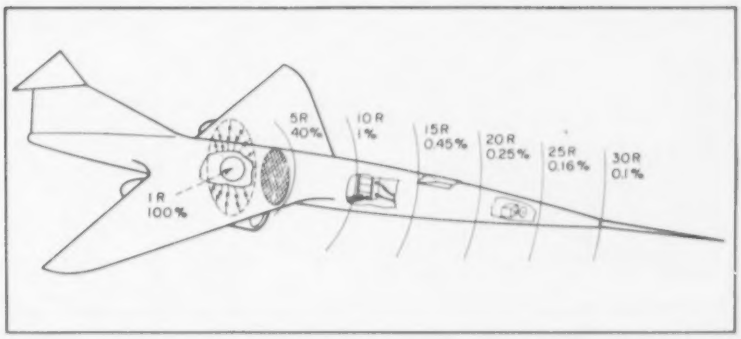

FIG. 1—Hypothetical arrangement of nuclear-powered aircraft shows relative radiation at distances in radii from reactor

Designing Electronics to Resist Nuclear Energy

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SUMMARY —— Nuclear power for aircraft and ships requires electronic equipment designed to operate in areas of high nuclear radiation. To obtain reliability, materials and components must be selected that will function properly under these conditions. Low susceptibility to secondary radiation is essential to permit servicing of equipment

DEVELOPMENT of nuclear-powered aircraft will result in nuclear radiation becoming an additional environmental factor for electronic equipment.

The components of nuclear radiation of concern to designers of electronic equipment are fast neutrons, slow or thermal neutrons and gamma rays. The radiation rates of each is a function of the power being generated, shielding and distance between the reactor and the equipment.

Considerable distance is likely to separate the electronic equipment from the reactor in a nuclear-powered aircraft. Radiation intensity is inversely proportional to the square of the distance from the source, or down to 1 percent at 10 radii and 0.1 percent at 30 radii of the reactor as illustrated in Fig. 1. As an order of magnitude, the nuclear reactor could easily have a radius of less than two feet.

Radiation Effects

Each type of nuclear radiation affects materials differently. Slow neutrons are captured by atoms in activation reactions. This induced artificial radioactivity will generally produce secondary gamma rays, as with cadmium. Boron absorbs slow neutrons and emits alpha particles. Of the two, the alpha particles are more desirable since they are easily stopped. The amount of artificial radioactivity induced by slow neutrons is a function of the cross-section for capture possessed by the material. Some metals, notably cadmium, cobalt and manganese have very large cross-sections for slow neutrons as can be seen in Table 1.

Secondary radiation adds to the general radiation problem and makes difficult the servicing of equipment once exposed to nuclear radiation.

Shielding against slow neutrons is a simple and inexpensive procedure. A quarter-inch shield of boron carbide-aluminum alloy will attenuate the slow neutron flux by a factor of 10^6.

Fast neutrons do not have the large cross-section for capture possessed by slow neutrons, but they have a large kinetic energy. A nuclear reactor will produce neutrons with energy up to 15 mev but the bulk of those to be contended with are around 1 or 2 mev. Fast neutrons damage by elastic collision with atoms in a crystal structure or chemical compound.

Gamma rays have far smaller cross-sections for reaction than fast neutrons, so cause little radio

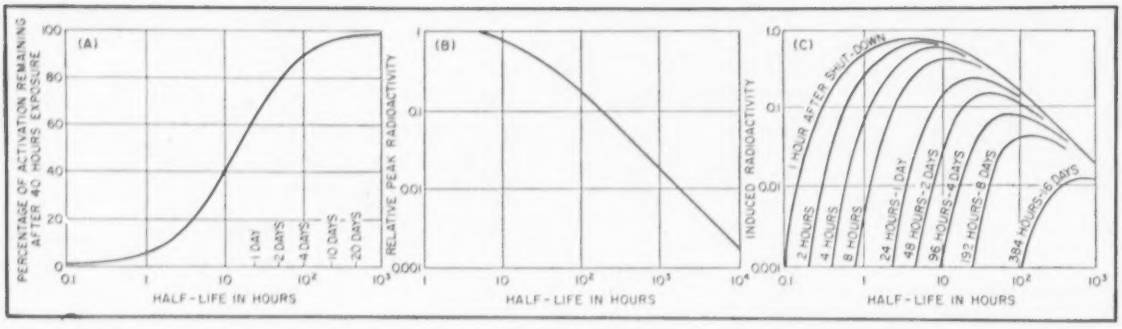

FIG. 2—Residual activation (A), radioactivity at shutdown (B) and relative radiation (C) of materials as a function of half-life

activation. Ionization of gas by gamma rays is less than for an equal number of fast neutrons possessing the same energy. Except for ionization and reactions with electrons, gamma rays are not particularly damaging to electronic equipment in quantities of the order of magnitude used here (1×10^{15} per cm^2). Appreciable damage may begin to show at 10^{18} gamma rays per cm^2.

Two Techniques

Design factors to be contended with by the engineer are radio activation, ionization, and structural damage. Radioactivation will restrict the serviceability of any equipment. Two techniques are possible: Materials with large cross-sections for capture of slow neutrons with gamma secondaries should be avoided or reduced to a minimum: and materials with short half-lives should be used for structure. An example of the first consideration is use of nickel or tin in place of cadmium plating. In the second instance, aluminum has a very short half-life (2.4 minutes) where as iron has a 2.06 year half-life. Iron activation would build up throughout the life of the equipment, but aluminum activation would be reduced to 0.017 percent of peak value in 30 minutes.

Figure 2A illustrates build-up of induced radioactivity during an operating period of 40 hours. Less than 1 percent of the total activation of aluminum would remain at the end of the irradiation period. On the other hand, the secondary radiation rate at shut-down would be much higher for aluminum than for iron, as is shown in Fig. 2B. Figure 2C compares the half-life parameter on a basis of radiation rate and time after shut down.

Both aluminum and iron are almost invariably used in the form of alloys. In considering an alloy for use in a nuclear radiation environment, the properties of all components must be evaluated. Cobalt is a component of aluminum-alloy magnets, generally, and has a large secondary radiation. If the equipment is to be serviced, then cobalt-containing materials should be shielded with boron alloy.

Gas Problems

Ionization is not generally a problem in metals or in ionic-bond materials. However, in air, gases or in insulators it can be a severe problem. In waveguides, ionization will reduce the maximum power that can be maintained with-

Table I—Nuclear Properties of Materials

Material		Atoms per cc x10^{22}	Cross-Section in Barns			Percent absorbed per cm	Half-Life of Isotopes
			Slow neutrons	Maximum	Fast neutrons		
Aluminum	Al	6.03	1.5b	10b	3b	10	2.4 min
Barium	Ba	1.53	10–18b	80b at 80 ev	6–12b	14	86 min
Beryllium	Be	12.3	6–8b		6b		2.7x10^8 yrs
Cadmium	Cd	4.61	20–8kb		4–7b	25	5.1 yrs
							2.5 days
Chromium	Cr	8.22	6–28b		3.5b	29	
Cobalt	Co	9.09	13–40b	7000b at 140 ev	3–20b	100	10.4 min
							5.28 yrs
Copper	Cu	8.46	8–35b		2–6b	34	5.14 min
							12.8 hrs
Germanium	Ge		10b	100b at 100 ev	3–10b		57 sec
							82 min
							12 hrs
Gold	Au	5.89	30–450b	30kb at 5 ev	4.5–10b	43	2.7 days
Iron	Fe	8.48	10b		3–7b	42	2.96 yrs
Lead	Pb	3.30	10b		10b	33	3.2 hrs
Magnesium	Mg	4.31	3.5b	22b at 90 kev	5b	22	9.5 min
Manganese	Mn	7.89	4.5–20b	2000b at 300 ev	50b	100	2.6 hrs
Mercury	Hg	4.07	45–450b	500b at 34 ev	5–10b	30	47 days
Molybdenum	Mo	6.4	6.5–15b	900b at 40 ev	4–10b		67 hrs
Nickel	Ni	9.13	25–30b	80b at 16 kev	6b	55	5.3 yrs
Oxygen	O	5x10^{22}	4–12b	14b at 0.44 mev	4b		
Platinum	Pt		10–20B	2kb at 12 ev	6–10b		
Selenium	Se		10–60b	90b at 27 ev	3.5–10b		67 sec
Silicon	Si	5.19	3b	11b at 0.2 mev	3b		2.6 hrs
Silver	Ag	5.67	18–100b	12kb at 40 kev	4–7b	31	24 sec
							2.3 min
Tantalum	Ta	5.53	10–25b	13kb at 4 ev	5–10b		16.4 min
							111 days
Tin	Sn	2.92	2–5b	60b at 100 ev	4–7b	16	250 days
Titanium	Ti	5.64	4–10b	100b	5b	28	5.8 min
Tungsten	W	6.31	8–28b	14kb at 20 ev	5–10b	45	24 hrs
							77 days
Vanadium	V		6–20b	70b	6b		3.9 min
Xenon	Xe		10^6–3x10^{6}b				5.3 days
							9.13 hrs
Zinc	Zn	6.58	4b	140b at 500 ev	3–10b	36	250 days

out breakdown. This problem can be solved by pressurization.

Gaseous tubes, which depend on ionization for operation, are not particularly affected by presence of nuclear radiation. However, gas-amplification phototubes are severly affected. Thyratrons require a grid-cathode ionization intensity several orders of magnitude greater than the probable radiation could cause, so no false-firing is likely.

High-voltage supplies and pulse modulators require additional insulation over usual requirements due to presence of ionization. Where air pressure can be used, pressurization is as effective as in waveguide. Where pressurization is impractical, immersion in silicone oil or encapsulation by plastics might be used. Leakage resistance of plastics and other insulators will be reduced by a factor dependent on radiation rate, but possibly as large as 10^2. The battery effect is also due to ionization. A conductor insulated from ground will acquire an appreciable potential with respect to ground due to unidirectional travel of ionizing radiation. However, the current is very small and constant, so that the potential developed drops rapidly with decreasing resistance to ground.

Probably the most serious effect of fast neutrons is on semiconductor devices. Data available in the form of test results is somewhat contradictory, but apparently failure may be expected in the interval of 10^{13} to 10^{16} fast neutrons per cm^2. Germanium diodes tend to fail by going ohmic while silicon diodes increase in resistance in both directions.

Some tests indicate the silicon diodes last longer under irradiation than germanium diodes, while other tests indicate the opposite. Only limited data is available on transistor tests. It is likely that transistors are more susceptible to irradiation than diodes.

Shielding

Shielding against fast neutrons is mainly a matter of moderating (slowing down by collision) and capture at the thermal energy level. Neutrons lose energy in the largest increments when colliding with objects of equal mass, so the best moderators are materials containing large quantities of hydrogen.

Water is used as a moderator, but 24 cm of H_2O is required for a 10-to-1 attenuation of fast neutrons. Certain plastics are more effective, but the best according to data available is polyethylene, which requires 15.6 cm.

A material known as tetramethyl - ammonium - boro - hydride will attenuate fast neutrons by 10-to-1 in 3.5 inches, and the included boron will soak up the thermalized neutrons. Its density is listed as 0.813 and it is reported stable to 300 F.

If fast neutron shielding is used, it probably will be used only for semiconductor devices.

Table II—Radiation Resistance of Electronic Materials

Low	Medium	High
Cellulose acetate	Phenolic, organic filler	Ceramics
Cellulose acetate butyrate	Polyester resin	Epoxy resins, mineral filled
Cellulose Nitrate	Allyl diglycol carbonate	Glass
Fluorothene	Polyethylene	Glass-bonded mica
Melamine-formaldehyde		Mica
Methyl Methacrylate		Phenol formaldehyde
Phenolic		Polyester resin, mineral filled
Polyamide		Polyethylene terephthalate
Polychlorotrifluoroethylene		Polystyrene
Tetrafluoroethylene		Polyvinyl carbazole
Urea formaldehyde		Porcelains
Vinyl chloride acetate		Silicone rubbers
Vinylidene chloride		

Threshhold Point

In general, little or no change in physical or electrical properties of plastic materials have been observed at 1×10^{16} neutrons per cm^2. However, that amount of radiation appeared to be a threshold point for damage to be detectable for many materials.

The effect of radiation on plastics and other insulators appears in capacitors and inductors, principally. Paper, being a complex organic material with low radiation resistance, will have to be replaced by materials such as mica, glass, ceramics, mylar and silicone materials depending on the application. Magnetic properties of metals and ferrites appear to be unaffected by radiation dosages far beyond anything contemplated here.

Components are available that can operate at high temperature and for extended periods in a radiation environment. Glass capacitors and fused-oxide resistors appear very good. Monolithic ceramic capacitors are in the same class. Some mica capacitors have operated with little modification of properties through extended periods of irradiation, but others have failed due to structural failure of the encapsulating plastic. Ceramic encased disc ceramic capacitor should be good and mineral-filled epoxy resin on disc ceramics should also be good.

Metals are very little affected by nuclear radiation in their physical or electrical properties at the radiation flux levels dealt with here. Wire-wound resistors, however, may fail because of insulation failure. A continuous, flexible ceramic coating, if possible, would be highly desirable. Metal film, or other film-type resistors, appear to have good radiation resistant properties.

Inductors wound of foil (preferably aluminum rather than copper for activation reasons) appear advantageous for several reasons. Space factor is better and heat conduction is considerably better. If aluminum with its natural oxide and auxiliary insulation, such as mylar, is used, the maximum mylar temperature will be reduced for given surface temperature. Life, hence reliability, will be increased. Electromechanical devices such as relays, motors and selysns fall in the same class as inductors in their electrical design.

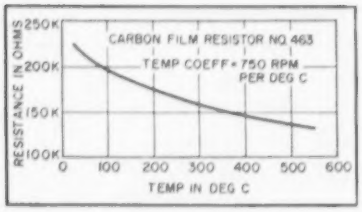

FIG. 1—Effect of temperature on 225,000-ohm GE carbon film resistor

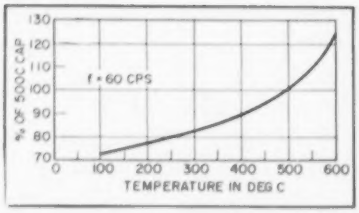

FIG. 2—Effect of temperature on typical mica capacitor unit

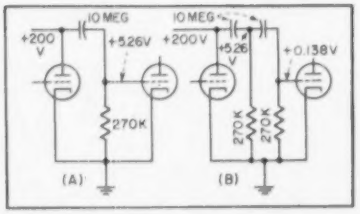

FIG. 3—Two coupling capacitors decrease effect of d-c leakage on grid bias

SUMMARY—Component-by-component survey of problems involved and progress to date in achieving reliable operation in 500 C temperature range. Enough components of various types are now produceable to permit construction of subassemblies for multivibrators, pulse preamplifiers, amplifiers and other circuits. Some withstand nuclear radiation, shock and vibration as well as high temperature

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HIGH-TEMPERATURE

STEADY PROGRESS is being made toward the product design stage of electronic subassemblies capable of operation in the 500 C range. Although such subassemblies are not yet off-the-shelf items, specialized circuits for particular applications can and have been built. Resistance to both high temperature and nuclear radiation is demonstrated by the new components and subassembly approaches.

Components are available now for the production of basic circuits such as amplifiers, multivibrators and clippers capable of operating satisfactorily at 500 C. These components are in general prototypes of what will eventually follow. Their mechanical design in particular is by no means optimized. In most cases physical size and weight are high in relation to electrical performance. Housings and terminations are often crude. Most are semi-handmade.

It is certain that present designs will be refined and desirable that they be standardized. With time, the limitations and gaps will be filled. Perhaps it is significant that vacuum tubes, which might seem to be the most difficult components to design for high-temperature operation, are in fact the most highly developed at this time.

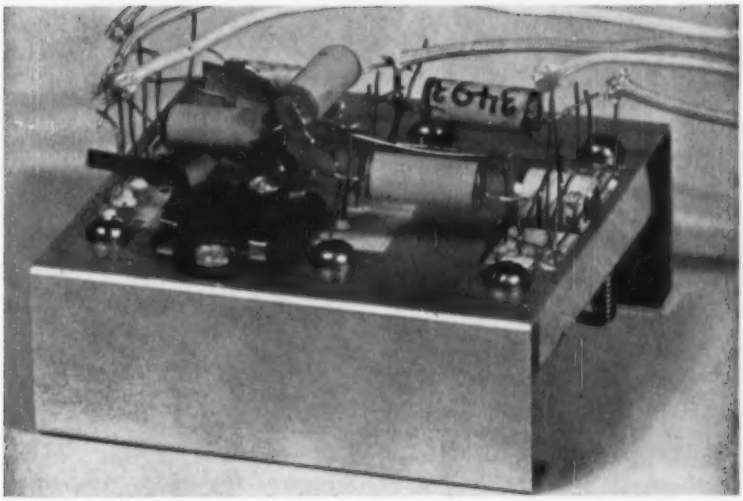
A number of vacuum tubes capable of operation at 500 C are in various development and pilot production stages for defense applications. These generally use titanium and a thermally matching ceramic of the Forsterite type in stacked co-planar construction. Connections may be made to the tubes by socketing, by direct spot-welding or by brazing wires to the tube electrodes.

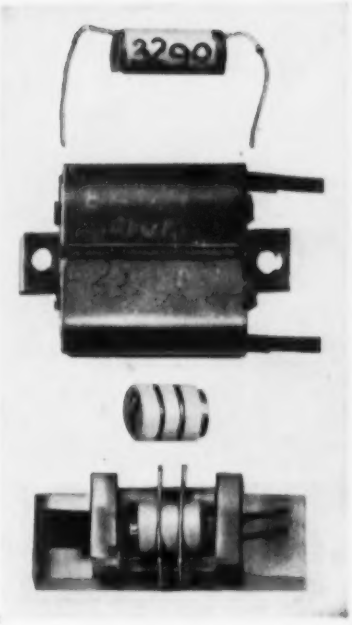
Tubes

The new high-temperature GE tube line comprises a medium-mu triode, a high-mu triode, a defense applications uhf r-f amplifier and a power triode with 12.5-watt plate dissipation capability. The specific external shape of these new tubes is not yet finalized. It is expected that the final design will provide for multiple-point mounting directly to a printed wiring board. This construction will extend the inherent ruggedness of the tube to the subassembly.

Resistors

Resistors capable of operation at 500 C are already available in sample quantities for experimental use in some applications. GE resistors utilize a resistive film deposited on the inside of a hollow ceramic tube. The resistors are sealed by using a metal-ceramic sealing technique at high temperature and low pressure. Resistor values to above 1 megohm are available. Although new and improved resistive films are under development, the presently-available resistors exhibit a negative temperature coefficient which varies with resistor value much as in Fig. 1. A temperature coefficient of 0.06 percent per deg C is not uncommon for a 250K carbon film resistor, and this represents a 29-percent





FRONT COVER: Operating tests in 500 C oven and on charcoal fire show that printed ceramic chassis using silver conductors performs equally as well as above metal-chassis subassembly with inset ceramic terminal strips, both using metallized resistor, mica capacitor and ceramic tube shown at right

SUBASSEMBLY DESIGN

change in resistance for a temperature rise from 25 C to 500 C.

The effect on gain of such resistance changes can be reduced by using large amounts of feedback, and this will surely be the technique used for the time being. Meanwhile, extensive efforts are being made to reduce the temperature coefficients of high-value resistors. Other research is being aimed at development of badly needed carbon-film power resistors (about 10 watts), resistors in the 10-megohm range, high-frequency resistors, precision resistors, variable resistors and potentiometers for operation at 500 C.

Capacitors

At present, capacitors for the 500 C range are in pilot production, based on a stacked mica design. This utilizes 1-mil stainless steel electrodes, phlogopite mica splittings for the dielectric, an Inconel case and stainless steel leads. The present case provides mechanical protection and mounting provisions, but not a hermetic seal. Capacitors are available in sizes from 0.001 to 0.05 μf at a nominal 250-v d-c rating. Typical electrical characteristics are: 60-cps power factor at room temperature—3 percent; 60-cps power factor at 500 C—40 percent; change in capacitance from room temperature to 500 C—plus 33 percent at 60 cps, as shown in Fig. 2.

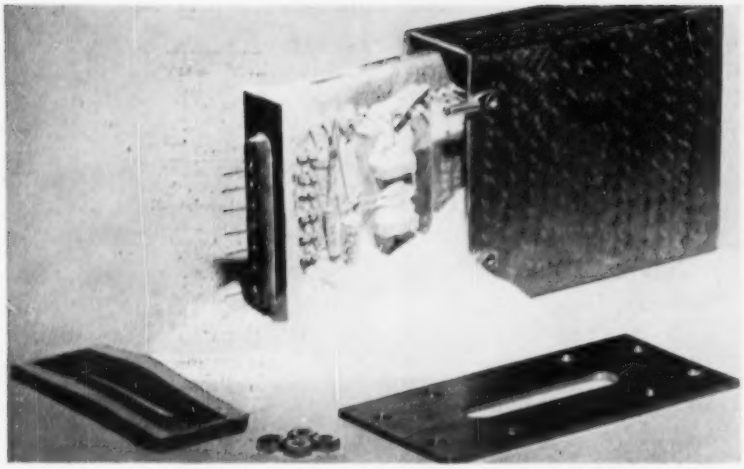
For plate coupling and grid blocking applications, d-c and low-frequency leakage resistance is a problem in high-temperature capacitors. Essentially, the difficulty is one of keeping the plate supply voltage of one stage off the grid of the next. Figure 3A illustrates the problem caused by leakage through the plate coupling capacitor. One way of getting around the trouble is to use another capacitor-resistor network, as in Fig. 3B. If the capacitors are not larger in the second case, low-frequency response will be sacrificed.

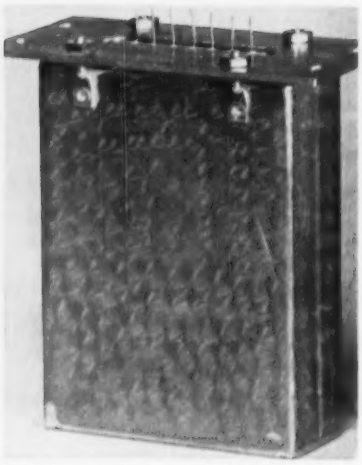
Another need in the high-temperature capacitor line is for large-value high-voltage capacitors. Until one is developed, such basic units as d-c power supplies will be difficult of achievement. The same capacitors are needed in screen bypass and cathode bypass applications. One special requirement here is resistance to nuclear radiation. In resistors and tubes this is achieved naturally because of the nature of the materials used.

Frequency-controlling capacitors and variable capacitors of any kind are also needed, although at first glance it would appear that these offer less of a problem, particularly where air is used as the dielectric.

Transformers

Few, if any, inductors are commercially available. Developers having need for inductors usually wind their own from silver or aluminum wire. Air cores have been used mostly, although certain magnetic materials and ferrites are useful at 500 C. Although power and high-voltage transformers have not been produced, filament





Subassembly encapsulated in alumina sand has high resistance to shock, vibration and nuclear radiation along with 500 C temperature rating. Component leads are welded to wire terminals cemented into holes in ceramic chassis

transformers using Ceroc or other ceramic-insulated copper conductors and iron cores have been successfully built and tested.

Wiring

Hook-up wire for high-temperature circuits should not be a problem for single uninsulated conductors. Nickel or Inconel-clad copper are two of several possibilities. A ceramic-coated copper wire is useful in some applications.

Subassembly Research

The high-temperature component art has progressed to the point where certain specialized and useful subassemblies can be constructed for operation in high-temperature environments. More work is required in component development before a wide variety of conventional subassemblies can be operated reliably, however.

Of every bit as much importance as component development is work in the area of subassembly designs. Besides standardization of component cases, lead configuration and mounting provisions, this work includes development and design in four fields: Connection methods (component to component, component to chassis, chassis to cable, etc); high-temperature printed wiring; suitable chassis or base materials; total subassembly mechanical design, including chassis, rack and shock-mounting provisions, and simplified assembly and test techniques.

For commercial system manufacturers or military weapons system manufacturers who require complete control or communication systems of proven reliability for operation at high ambients, the high-temperature component and subassembly art has not progressed to a point where it is directly usable. But simple devices must be built before complex ones, and the only way to achieve system operation at high ambients is to start by building useful and successful subassemblies.

The problem in connection development is to find a substitute for soldered joints. The desirability of 500 C printed wiring has resulted in evaluation of metallizing techniques, mechanical strength, ease of making connections and simplicity of the process.

Breadboard Example

Work during the past year has led to subassembly configurations which are feasible for operation in high temperature and high nuclear radiation environments. In addition, one of the configurations is also suited to high shock and vibration conditions.

The first design resulting from subassembly research is an adaptation of conventional techniques to high-temperature requirements. A conventional sheet aluminum chassis can be used. In place of the conventional terminal strip made of phenolic laminate and tinned brass, a ceramic block is used. Nickel wire tie points are set into the ceramic and anchored with a high-temperature inorganic cement. Connections between components and the tie points on the ceramic block are made by spot welding. Another connection technique which has shown considerable promise is wire-wrapping.

Most light components can be suspended between the tie points on the ceramic blocks by the strength of their own leads. This method would be used for resistors and some light capacitors. For heavier components, such as stacked mica capacitors, the electrical connection and mechanical mounting are separated. Larger capacitors can be bolted or riveted directly to the chassis.

If bolt and nut construction is used, the nuts may be drawn up loosely to allow for thermal expansion, then held in place with a drop of Saureisen cement. Another method is to utilize high-temperature spring lock washers made of Inconel X and draw the nut up tight against the washer.

Tube Mount

A novel method for mounting tubes of the metal-ceramic type is shown in Fig. 4. Using a special welding fixture, lead wires about 2 inches long are welded across the tube electrodes. Next the tube is placed on a grooved ceramic mounting block with nickel tie points suitably located on the block.

By bending the tie point wires in

toward the tube and spot-welding to the wire straddling the tube while the tie-point wires are under a flexural stress, a resilient harness is formed which serves as both the electrical connection to the tube and as a mechanical restraint.

The ceramic tube blocks can be mounted either above or below the top surface of the chassis. External connections for filament and plate power, signal input and signal output can be made by spot-welding wires directly to the appropriate tie points. Where necessary, woven glass tubing may be used to insulate one wire from another.

One advantage of the spot-welding connection technique is the extreme ease with which connections can be made and remade. Spot welding works best on materials of moderately high resistivity and most of the lead materials for high-temperature components now being developed fall into this category. Nickel lead wires spot-weld most easily. Even copper wires, if they are nickel-plated, spot-weld satisfactorily.

Encapsulated Example

The second high-temperature subassembly design, based on a modular approach, is intended for high shock and vibration levels. The base plate is a molded or fabricated ceramic base plate into which a number of nickel tie points are cemented with inorganic Saureisen cement, as in Fig. 5. The tie points are set along the two longer edges of the base plate at incremental distances corresponding to the minimum spacing between small components. At the present time, this is on a 0.200-inch grid system.

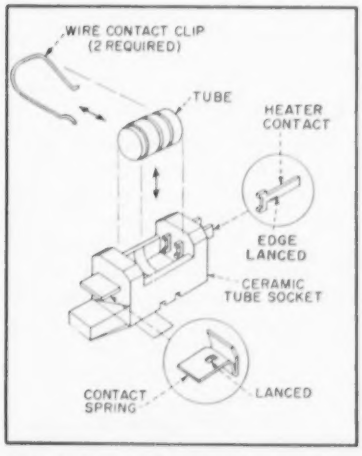


FIG. 4—Construction of 500 C socket for ceramic tube

The nickel tie points extend all the way through the ceramic base plate. Again, components including tubes can be assembled and spot-welded on one side of the base plate. On the other side additional components can be placed, or overhead or printed wiring connections can be made to the input and output terminals at the end of the base plate.

After complete assembly and test of the module, which could consist of one or two stages of amplification, a multivibrator or the like, the base plate is inserted into a mounting can which is fitted with locating tracks made of sheet spring material. The tracks serve to locate the base plate within the can and provide some degree of shock mounting.

The bulk of the shock mounting is provided by the next stage in the assembly operation, which consists of filling the air space between the base plate and the can with finely divided alumina powder. During the filling or potting operation the subassembly can is gently shaken so as to tamp down the sand. Assembly is completed by placement of a resilient gasket and a top mounting plate on the can.

Applications

The first subassembly configuration described features a tolerance to nuclear radiation as well as to temperatures above 500 C. The second design would be useful under high temperature, nuclear radiation, high shock or high vibration conditions, or any combination of them. Drawbacks of the designs are considerably higher cost per subassembly, much higher weight (especially in the second design), and the ever-present restriction imposed by the limited number of components presently available.

A typical application of such construction techniques includes pulse preamplifiers for nuclear pile instrumentation. The preamplifiers are designed to take the output of a radiation level gage such as an ionization chamber, amplify the signal and match the output impedance to that of a coaxial cable. The circuits could be extended to logarithmic flux amplifiers when suitable electrometer tubes and logarithmic diodes become available.

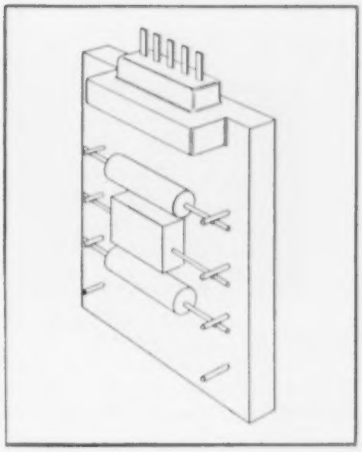


FIG. 5—Terminal arrangement in ceramic submodular chassis

Another application would be blast instrumentation at short range during nuclear detonations. A timing oscillator and several f-m oscillators built along the lines of the second design could furnish extensive temperature, pressure and shock data at extremely close distances to the fireball. Numerous other applications in both military and commercial systems exist now and more are sure to materialize in the future.

In general, any circuit or device whose operation is limited by thermal, nuclear, shock or vibration considerations stands to be improved significantly by using such designs.

The study described was carried on under subcontract from the GE Aircraft Nuclear Propulsion Dept. in Cincinnati, which is engaged in development work for the Atomic Energy Commission and the U. S. Air Force. Other GE departments participating in high-temperature component and subassembly development work are: ceramic tubes—Receiving Tube Dept., Owensboro, Ky.; resistors—Specialty Electronic Components Dept., Auburn, N. Y.; mica capacitors—Capacitor Dept., Hudson Falls, N. Y.; printed wiring subassemblies — Research Laboratory, Schenectady (front-cover multivibrator built by Dr. Walter Grattidge).

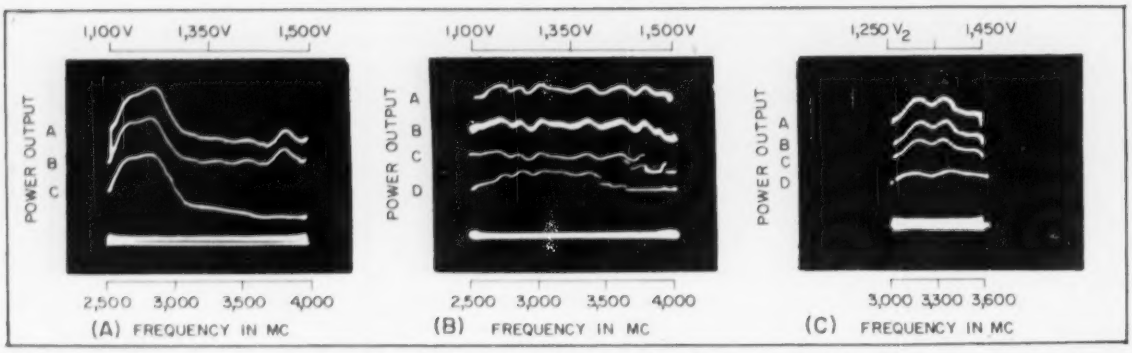


FIG. 1—Waveshapes show power output against anode voltage during wide-band operation in balun-ridge waveguide (A), tapered wave-guide (B) (breaks in *C* and *D* are from too-low control voltage) and during narrow-band operation in tapered waveguide (C)

Voltage-Tuned Magnetron

SUMMARY —— Stacked metal-ceramic miniature magnetron operating in 2-kmc to 4-kmc range has average output power capabilities up to ten watts. Effects of operation in tapered S-band waveguide and ridged waveguide are given and normal operating characteristics together with present and future applications are discussed

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VOLTAGE-TUNABLE magnetrons are capable of instantaneously changing frequency over almost a two-to-one range. The characteristics of the vtm make it suitable for application in a number of existing types of equipment and permit the development of new types.

The vtm tubes to be described have been designed for low lower output and are suitable for use in test equipment such as swept signal generators and spectrum analyzers. Other applications where their low power output can be used effectively are in measuring equipment such as f-m altimeters and f-m telemetering equipment.

Their use as local oscillators in receivers is another potential application but depends upon their noise output that, while not yet fully evaluated, appears to be comparable to that of reflex klystrons. When used in conjunction with broad-band power amplifiers, such as traveling-wave tubes, the vtm may be applied in radar, communications and countermeasures equipment where the ability to change frequency rapidly is a necessity.

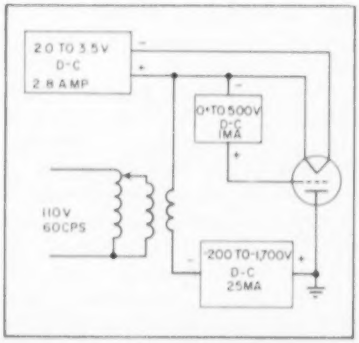
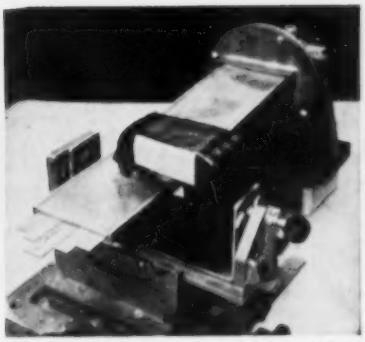


FIG. 2—Typical power supply requirements for the vtm

Characteristics

The vtm acts essentially as a constant-current generator as far as r-f power generation is concerned. While the frequency of oscillation is a linear function of the applied anode voltage, power output is a function of the r-f impedance presented to the tube by the external circuit. The impedance presented to the tube by narrow-band high-Q circuits can be made large resulting in the highest obtainable power output from the tube. Wide-band circuits inherently have low impedance and thus

The voltage-tuned magnetron is shown inserted in the balun-ridge waveguide (left) while hand (right) demonstrates size of unit



Magnet is shown in operating position over vtm inserted in tapered waveguide

For F-M APPLICATIONS

wide band operation of the vtm produces relatively low power output.

The power output-frequency characteristic of the tube in the balun-ridge waveguide wide-band cavity, with an anode center voltage of 1,350 v d-c and anode current of 15 to 20 ma, is shown in the oscillograph in Fig. 1A. Power output for various control voltages is shown in Table I. Power output variation results from the change in impedance with frequency of the balun-ridge waveguide circuit. Since the frequency is a linear function of the anode voltage, the abscissa may also be used for voltage scale. The dependence of the r-f power output upon the control electrode voltage is readily apparent.

Table I—Output Power Characteristics

Trace in Fig. 1	Control electrode voltage in volts	Average power output in watts
Fig. 1A		
A	600	3.7
B	500	2.9
C	400	1.0
Fig. 1B		
A	600	2.1
B	500	1.5
C	400	1.0
D	300	0.6
Fig. 1C		
A	600	6.5
B	500	4.6
C	400	3.4
D	300	2.1

The same tube inserted in a tapered S-band waveguide circuit produces an oscillograph as shown in Fig. 1B. It shows the wide-band power output characteristic as a function of frequency for various control electrode voltages. The applied voltages are identical to those used in the ridge-waveguide circuit measurements.

For the narrow-band operation shown in Fig. 1C, the modulation voltage is reduced and the impedance raised by adjusting the back cavity shorts. Since the power generated by the magnetron is a direct function of the impedance presented to it, the power output of the circuit adjusted for narrow-band operation is much higher than that of the broad-band circuit.

The ridge-waveguide wide-band circuit consists essentially of a ridge guide tapered to present an impedance match to a coaxial line. This circuit allows the tube to tune from 2,500 mc to 4,000 mc. Since this circuit is totally enclosed, little r-f shielding is required to adapt it to systems.

Power supply, modulator requirements and tube connection are shown in the block diagram of Fig. 2.

Future Types

It is expected that the vtm and circuit soon will be packaged with a magnet in a manner similar to that of packaged pulse magnetrons.

Work now under way in frequency ranges adjacent to that of this vtm will provide similar tubes for extended frequency coverage. To make them more suitable for military use, future tubes will be produced with high-temperature metal-ceramic sealing techniques that will enable them to be operated at higher ambient temperatures. These tubes also will be designed to withstand high levels of shock and vibration and will be capable of operating unpressurized at altitudes of 60,000 ft, thus making them suitable for airborne applications.

The authors are grateful to D. A. Wilbur, P. H. Peters and E. Turrentine. Their research work was supported by the Signal Corps under Contracts DA-36-039-SC-42699 and DA-36-039-SC-32279.

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(1) P. H. Peters, Jr. and D. A. Wilbur, Magnetron Voltage Tuning in the S-Band, *Proc NEC* **XI**, Oct. 1955.

(2) D. A. Wilbur and P. H. Peters, Jr., New Magnetron Principles, Symposium on Modern Advances in Microwave Techniques, Brooklyn Polytechnic Inst., New York, N. Y., Nov., 1954.

Ordnancemen load one of guns on mound outside laboratory. Projectile is fired through rectangular hole into Aeroballistics Laboratory, shown at right, in which range stations are located

SUMMARY — Multiple-photoflash technique for determining free-flight aerodynamic and ballistic characteristics of missile models uses predetermined-counter gating unit to control photographic exposures. Down-range increasing pulse rate for flash lamps properly spaces photographs of rapidly accelerating rockets under test. Exact number of flash bursts are set with toggle switches on control panel

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PRESET GATING UNIT

STUDY of rapidly accelerating missiles in the NOTS Aeroballistics Laboratory necessitated redesign of the gating units[1] which control the multiple-flash lamps that are used to photograph the missile models during free flight.[2] The new gating units provide a down-range increasing trigger pulse rate for the flash lamps so that satisfactorily spaced photographs can be made of burning, therefore rapidly accelerating, missile models now under test.

Two new features are incorporated in the redesigned unit: provision for dividing the frequency of the master timing pulses by one, two, four or eight as determined by the selector-switch setting on the panel; and determination of the number of pulses to be passed in gating action by electronic counters preset by toggle switches on the panel of each unit. The previous units had no means of dividing the frequency of the master timing. The number of pulses passed was determined by elapsed time after the start signal from the photoelectric unit; the time interval was generated by a phantastron.

System Operation

Figure 1 is a block diagram of the gating unit. Rectangles containing X numbers represent plug-in units.

The pulses from master timing, intensified by the pulse-stretcher amplifier, feed the timing-monitor amplifier and Schmitt trigger X_1. The Schmitt trigger feeds the chain of three high-speed binary counters, X_2, X_3 and X_4, which divide the frequency of master timing by two, four and eight. Positive pulse or square-wave output from either X_1, X_2, X_3 or X_4 may be selected by the timing-rate-divider switch which chooses a signal for gating either at the frequency of the master-timing signal or at $\frac{1}{2}$, $\frac{1}{4}$ or $\frac{1}{8}$ that frequency.

Not shown in the block diagram, but mechanically coupled with the timing-rate-divider switch, are switches which turn off the plate supply voltage to X_2, X_3 or X_4 when these counters are not needed. Pulses at the frequency chosen by the timing-rate-divider switch form the signal input to gate X_{10}.

The gate is constructed around a 6AS6 pentode. The gating line is connected to the suppressor grid that forms the second control element. If the voltage on the gating line is held more negative than a certain value, the value depending on the constants of the remainder of the circuit, the tube will not pass

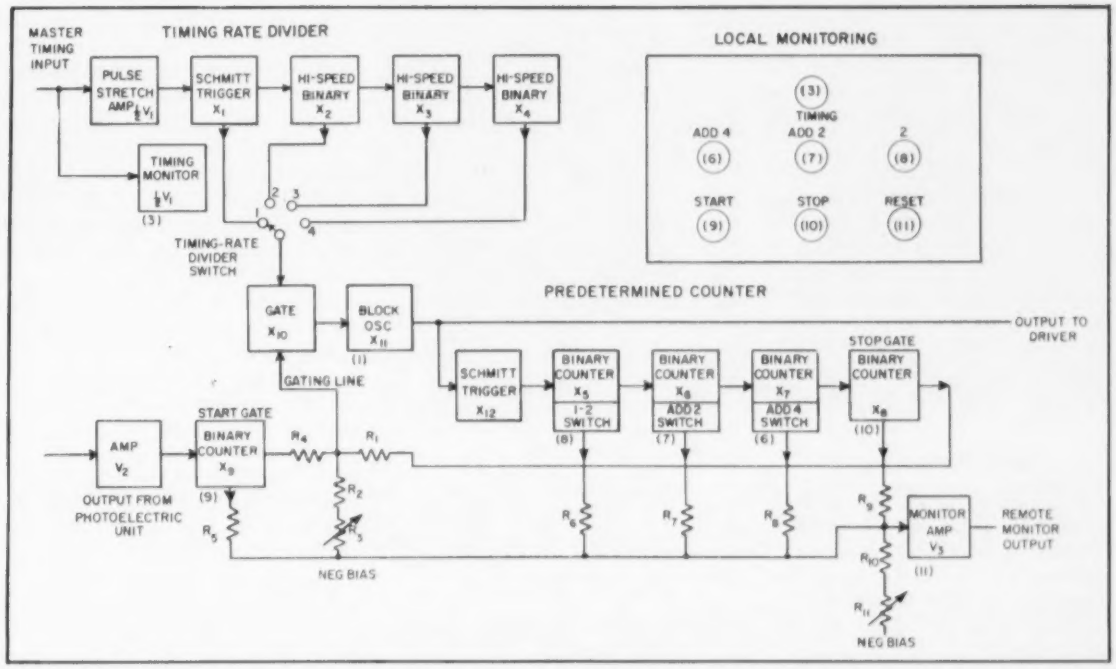

FIG. 1—Gating unit makes extensive use of plug-in circuits marked X in diagram. Panel of indicator box used for local monitoring is illustrated at upper right; lamp numbers correspond to outputs in block diagram

for Aeroballistic Testing

pulses. When the negative voltage is removed from the gating line, the tube will pass positive pulses applied to the signal grid, amplifying and inverting them. The output of gate X_{10} drives blocking oscillator X_{11} which in turn forms the output to the driver unit.

Blocking oscillator X_{11} also feeds, through Schmitt trigger X_{12}, the predetermined counter chain made up of binary counters X_5, X_6 and X_7. The output of this chain triggers binary counter X_8, whose function is to stop the action of the gate. A pulse from the photoelectric unit, intensified by amplifier V_2, trips binary counter X_9 and starts the gate.

Gating Sequence

The desired number of pulses to be passed by the gate, from one to eight, is set with the toggle switches of the predetermined counter. By resetting all binary counters, except those in the timing-rate divider, the predetermined counter is set in such a way that the gate will accept the preset number of pulses before impinging a negative pulse on the input of stop-gate binary counter X_8.

Reset also raises the output of X_8 to a high d-c value while output of start-gate binary counter X_9 is put at a low d-c value. When a pulse is injected into the binary circuit at the proper point, resetting results. A relay in the power supply, controlled either locally or remotely, generates the reset pulse.

The voltage on the gating line results from the outputs of start-gate driver X_9, stop-gate driver X_8, and the negative-bias supply fed through R_1, R_2, R_3 and R_4. The values of these resistances are proportioned so that under conditions of reset, the voltage on the gating line is held so far negative that the gate tube cannot pass pulses. The increase of output voltage from binary counter X_9, when it is triggered, brings the voltage on the gating line to a positive value and the gate starts passing pulses. When the preset number is passed by the predetermined counter, it triggers stop-gate binary counter X_8. The resultant drop in output voltage of X_8 again brings the voltage on the gating line to a value so highly negative that the gate does not pass any more pulses.

Remote Monitoring

All five of the binary counters which are affected by rest and the negative-bias supply are tied together through resistances R_6 to R_{10} to the grid of V_3 the remote moni-

tor amplifier. The resistances are connected and proportioned so that only with all five binary counters properly reset is the voltage on the grid of V_3 held near or beyond the plate current cutoff value for the tube.

If one or more of the five binary counters are not properly reset, the voltage on the grid of V_3 becomes positive, causing the plate to draw current at its saturation value. Zero or low plate current in V_3, with resultant high plate voltage, occurs only when everything is properly reset. The voltage at the plate of V_3 forms the remote monitor signal.

Local Monitoring

Local monitoring is achieved through the small test box which is plugged into the local monitoring connector on the front of each gating unit. This box is included in the block diagram, Fig. 1. One neon lamp monitors the master timing input and is lit only when the timing pulses are of sufficient amplitude and proper polarity.

Three neon lamps monitor the status of conduction of the three predetermined binary counter stages. When the gating unit is reset each of these three lamps lights if the toggle switch associated with the binary counter chain is in its maximum or add position. These three neon lamps flicker on and off during the gating action, then remain on after the action is completed.

A fifth neon lamp is provided for monitoring the start-gate binary counter and a sixth, for the stop-gate binary counter. These two lamps are lit when their counters are reset.

A seventh neon lamp is a local over-all monitor and is lit only when all binaries are properly reset. Its operation parallels that of the remote monitor.

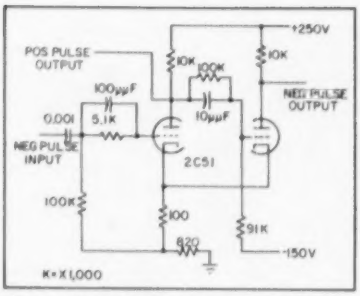

FIG. 2—Functional diagram of Schmitt trigger used in gating unit

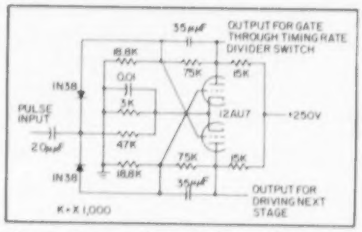

FIG. 3—One of three high-speed binary circuits used in gating unit

Circuits

Standard NOTS plug-in units are used with the exception of the blocking oscillator which is a special design for this installation.

Master timing pulses arrive at the gating unit in balanced form in a twin conductor coaxial connector and are converted to unbalanced form (one side grounded) by a pulse transformer. A single stage of pulse-stretching amplification (first half of V_1) is more than sufficient for driving the Schmitt trigger X_1. Separate amplification is provided by the second half of V_1 for driving the timing monitor neon lamp in the local monitoring unit.

Schmitt triggers X_1 and X_{12} (Fig. 2) are connected to operate on a negative input signal by having their input grid returns tied to the tap on the cathode resistance. Both positive and negative outputs of X_1 are employed. The positive output is routed to position 1 on the timing-rate divider switch; the negative output drives the first of the three binaries that make up the timing-rate divider. The positive output of X_{12} is not used while the negative output drives the first of the three binaries that make up the counter.

Each of the three units in the timing-rate divider chain is a high-speed binary counter (Fig. 3). Input coupling is provided by a capacitor and two crystal diodes. In each of these binaries, the signal output to the timing-rate-divider switch is taken off the plate circuit not used to drive the next stage.

For aid in understanding the operation of the toggle switch, monitor and reset circuits concerned with each of the predetermined counter binaries, a functional diagram of X_2, the first of the chain, is given in Fig. 4. The left or right reset input is chosen for the reset function by the toggle switch.

The reset voltage pulse is passed through a small internal neon lamp before it is applied to the toggle switch. The neon lamp acts as conductor for the high-voltage reset pulse. This lamp is a nonconductor at all times other than at reset.

The other side of the toggle switch connects with either the left or right-hand plate circuit for remote monitoring. The connection for local monitoring is made at the plate circuit not used to drive the succeeding binary stage.

A functional diagram of the gate and blocking oscillator is shown in Fig. 5. The square waves or pulses on the signal input line from the timing-rate-divider switch are differentiated before they are fed into the control grid of the 6AS6 gate tube. The plate of the gate tube is directly connected to the plates of the 6J6 blocking oscillator. The pulse output of the blocking oscillator is obtained by passing the plate current through R_1.

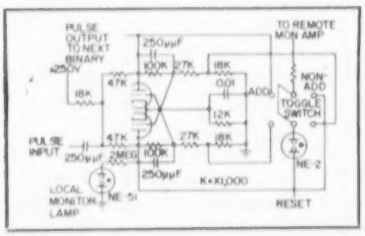

FIG. 4—Typical plug-in predetermined-counter stage

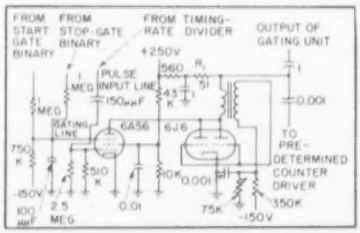

FIG. 5—Combined function diagram of plug-in gate and blocking oscillator

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Organs on production line have final frequency check before shipping

ELECTRONIC ORGAN Uses Shared Oscillators

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Sepulveda, Calif.

SUMMARY — Low-cost organ design reduces number of tone oscillators required from 61 to 16 by sharing oscillator for three adjacent keys and by reducing keyboard range by one octave. Solo control provides attenuation to accentuate low or high end of keyboard

IN AN ELECTRONIC organ, accepted musical practice establishes the boundaries of design and performance and electronic techniques must provide the musical effects desired within these boundaries.

To lower the cost, there are a number of musical limitations which may be imposed. Among these are; provision for only one manual instead of two; use of a self-contained amplifier and speaker instead of a tone cabinet; use of a manual having four octaves of playing keys instead of the more usual five octaves and conservation of tone generator requirements by the use of shared oscillators.

Of these four limitations, only the last two noticeably affect the musical facility of the instrument. One of the most expensive items in any electronic organ is the tone generator. This will include the oscillators and/or frequency dividers required to generate all the musical frequencies of the organ. In an instrument where an oscillator is provided for every playing key of the manuals and pedal board, the number of oscillators and their cost will be a major item.

Shared Oscillators

One way of reducing the number of oscillators is to reduce the number of playing keys. The standard organ manual has five octaves of keys. In the organ described here the manual has been reduced to four octaves by omitting the highest seven keys from the top octave, and the lowest five keys from the lowest octave. This leaves four octaves of keys plus one key, in the most used range of the keyboard.

Another way of reducing the number of oscillators is by oscillator sharing, in a circuit which permits any one of three adjacent playing keys to selectively cause the shared oscillator to generate the frequency associated with that particular key. The three keys are connected in a sequence circuit, so that if any two of the keys are depressed at the same time, only the higher note will be heard. It is seldom musically necessary to play two adjacent notes separated by a whole tone or less, and it is upon this point that the economy of the

design is justified. This four octave organ requires 16 oscillators as compared to 61 for a conventional five octave organ.

The same sharing principle may be applied to the pedal keys by using a single oscillator arranged to generate selectively any one of thirteen consecutive notes, to provide one octave of pedal bass. Here the sharing is not a musical limitation because it is not customary to play more than one pedal note at a time. The keyboard system is shown in block form in Fig. 1.

Tone Generator

The grid of the Hartley oscillator, shown in Fig. 2, connects to the highest of a series of three switches forming a sequence circuit. Cathode bias normally holds the grid cutoff through R_1 and the coil, to ground. When the switch for note C is closed a high positive potential is applied through variable resistor R_5 to the grid initiating oscillation. Simultaneously capacitor C_2 is connected across C_1 and the oscillator inductor to lower the oscillator frequency by a selected amount, in this case two semitones. Capacitor C_4 is a blocking capacitor. Potentiometer R_5 serves as a fine-frequency adjustment by operating as a voltage divider in conjunction with R_1 and the input conductance of the tube, to vary the positive voltage applied to the grid. Oscillator constants are chosen to provide a suitable frequency with respect to grid-bias sensitivity. If the C-sharp switch is simultaneously operated, the sequence is interrupted and C_3 is connected across the coil in place of C_2 to increase the frequency approximately one semitone, while R_5 becomes the fine-tuning adjustment. When the D switch is operated, breaking the sequence to the two lower keys, no additional capacitor is connected across the tuned circuit, and C_1 determines the frequency of oscillation, with R_5 now acting as the tuning control.

A six-cps vibrato signal is superimposed upon the d-c keying potential. This causes the voltage at the grid to fluctuate periodically to produce a small change in the oscillator frequency for a musical vibrato. The amplitude of this six-cps signal controls the degree of vibrato.

Two output circuits are taken from each oscillator. The flute signal is derived from the tuned circuit and is relatively free of harmonics. Additional filtering of this signal is provided by low-pass networks at the output of each oscillator and in the voice control panel. The complex signal from which all other voice qualities are derived is taken from the plate circuit of the oscillator and is rich in harmonic content. Isolation is provided by resistors R_6 and R_7 so that the respective output circuits of all oscillators may be connected together to provide common flute and complex output busses.

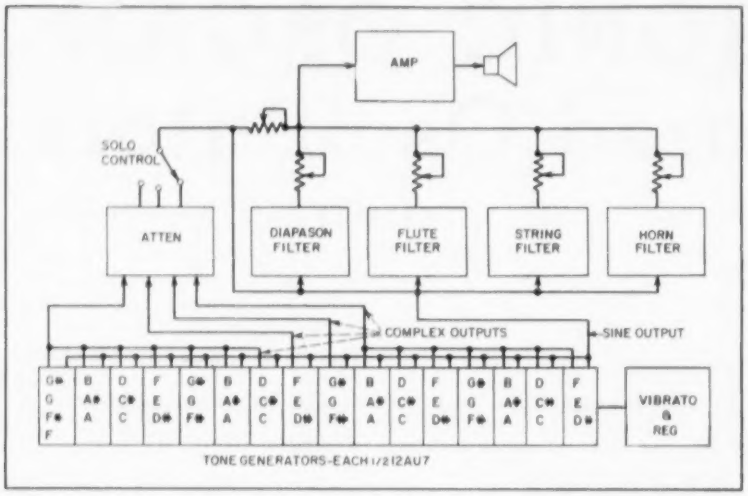


FIG. 1—Sixteen tone generators, each controlled by three adjacent keys, provide basic signals for modification by filters

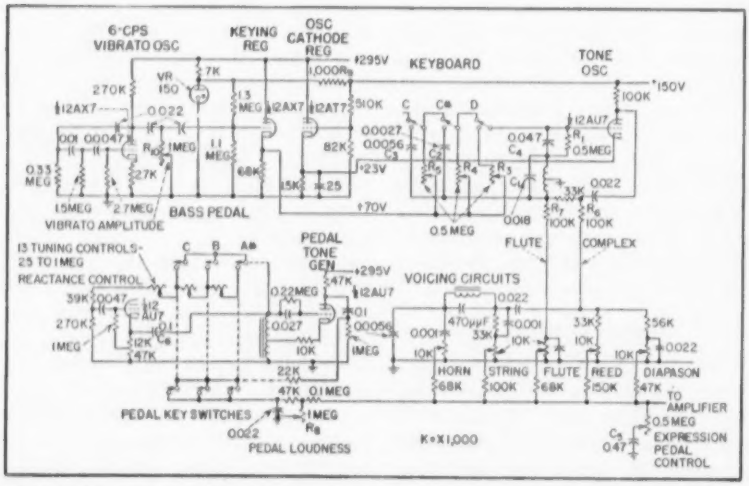


FIG. 2—Organ circuit shows keyboard control of oscillator for key of C. Other keys use similar circuit with different component values

Voicing and Expression

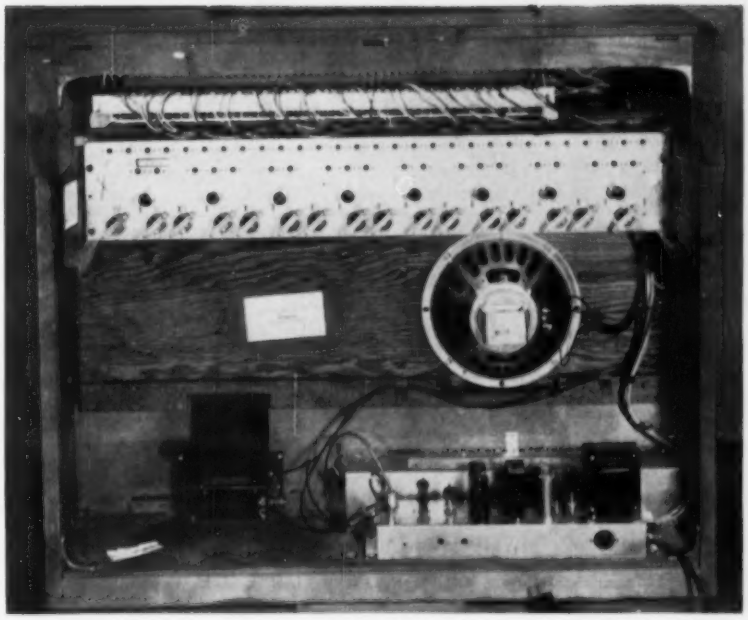
The voicing control potentiometers which vary the output of each voice network, are continuously adjustable and are located on the control panel of the instrument. These permit the player to mix together a great variety of the five available voices while playing. The diapason voice is obtained from a low-pass circuit following the complex signal while the reed uses the complex signal without modification. The string filter emphasizes the higher harmonics, and the horn uses a peaked-response circuit, with the

maximum output at about 1,000 cycles. The outputs of all voicing circuits are combined in a passive mixer circuit together with the signal from the bass-pedal oscillator and fed to the input of the amplifier.

The expression control varies loudness with capacitor C_5 providing bass compensation to complement the loudness characteristic of the human ear.

Bass Pedal

The single pedal-oscillator of the organ is tuned by a cathode-follower reactance control tube. The thirteen pedal key switches are each a pair of single-make switches, the upper contacts controlling the tuning, and the lower contacts connecting the oscillator output signal to the amplifier. The tuning contacts are arranged to connect the signal from the oscillator inductor to the grid of the control tube through a resistance of selected value. This resistance may include one or more of the thirteen tuning controls which are connected in series. The amount of resistance controls the amplitude of signal voltage reaching the grid of the control tube. This signal has the same phase as the tuned circuit voltage at C_5, and consequently appears again in the same phase at the cathode of the tuning tube. Since the cathode voltage is in series opposition with the inductor voltage, the voltage across the capacitor is reduced. This reduces the current in the capacitive arm of the resonant circuit, thus making its apparent capacitance smaller, raising the resonant frequency of the oscillator. The amplitude of the voltage applied to the grid of the control tube through the tuning potentiometers, therefore, determines the frequency of the oscillator.



Rear view of organ shows tone generator chassis at top for keyboard. Chassis at bottom supplies pedal notes using single oscillator for the 13 tones

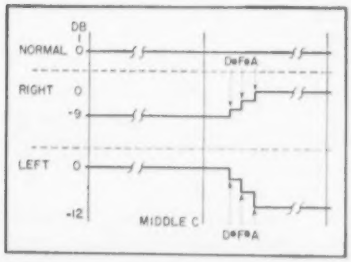


FIG. 3—Attenuation characteristic for solo control in its three positions

Power Supply and Regulators

Musical demands regarding organ tuning impose rigid requirements on the frequency stability of the oscillators, and voltage regulation is used for both the common cathode bias and the 70-volt keying potential. Both regulators are cathode followers whose cathode voltages are held constant by applying fixed positive potentials from a gas reference tube to their grids. Resistor R_9 provides additional correction voltage signals to the grid of the cathode bias regulator as a function of increased oscillator plate current, when several notes are played simultaneously.

The vibrato oscillator, whose 6-cycle output is fed to the grid of the keying regulator may be controlled by the organist by potentiometer R_{10} located on the control panel of the organ.

A conventional power supply provides plate power to the power amplifier and gas regulated power to the oscillators. The plate current for the oscillators is small, each oscillator drawing approximately one milliampere when one of its associated keys is operated. Therefore when a full eight-note chord is played, only 8 ma are needed.

The amplifier output stage uses a pair of 6V6 tubes, which deliver ten watts to a ten-inch permanent magnet speaker.

Solo Control

The solo control provides a choice of three conditions of manual output level from the complex signal voices, as follows: left-hand end of keyboard accentuated, equal loudness from all keys (normal) and right-hand end of keyboard accentuated.

The left hand is attenuated approximately 9 db in the right-hand solo position, while the right hand is attenuated approximately 12 db in the left-hand solo position. The transition between the two levels is accomplished gradually in 3 equal steps of attenuation, over an intervening range of 8 notes by separating the outputs of 4 adjacent oscillators in the middle of the keyboard and attenuating each a different amount. Figure 3 shows the attenuation characteristics of the solo control.

The authors wish to acknowledge the contribution to the final product made by Mr. Donald Bonham.

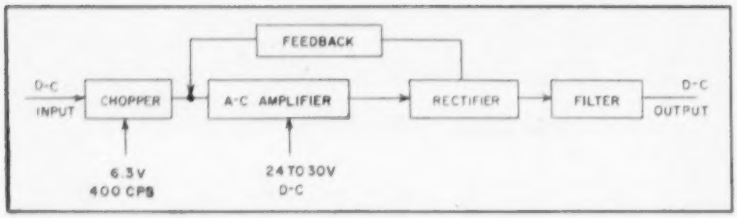


FIG. 1—Block diagram of transistorized chopper system utilizes synchronous modulation of d-c input and demodulation of output from a-c amplifier

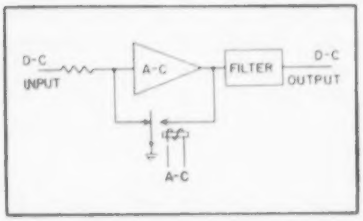


FIG. 2—Basic full-chopper d-c amplifier was adapted to missile instrumentation

SUMMARY —— Chopper-type d-c amplifier uses available channels to indicate missile temperatures in an airborne telemetering system. Unit has voltage gain of 1,000 with 5-volt d-c output and linearity within 2 percent over the full output range. Input impedance is 100 ohms and response is flat from zero to 10 cps. Stability is within 2 percent up to 10 g vibration at 1,000 cps or over temperature range from —65C to 85C

MISSILE TELEMETER

In an airborne telemetering system, the thermocouple may be far physically separated from the telemeter and make the thermocouple appear as a generator of finite, but not necessarily constant, internal impedance. Typical impedances may be 10 to 50 ohms and may vary as much as 20 percent due to temperature changes.

Terminal emf of this generator may vary from 0.1 to 50 or more millivolts, depending on the application. While response time of a thermocouple is generally considered rather low, the amplifier should pass faithfully a range from 0 to 10 cps. The reference junction can be considered as a source of bucking voltage in series with the couple.

Most telemetering systems operate from voltage actuated devices, with the possible exception of transistorized subcarrier oscillators, or the ptm or pwm systems and a load of 250,000 ohms is typical. An amplifier with a basic voltage gain of 1,000 is adequate to supply up to 5 volts d-c output. A simple attenuator in the amplifier input or output can be used to adjust the output level for less gain.

Power available in most instances is 115 v at 400 cps, with a

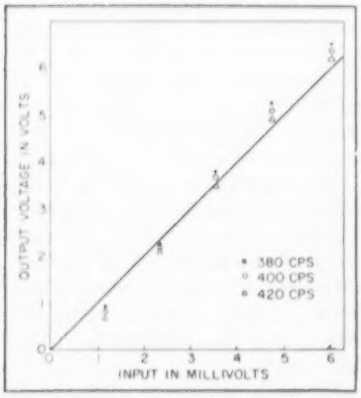


FIG. 3—Line frequency variation for 380, 400 and 420 cps at 6.3 volts rms

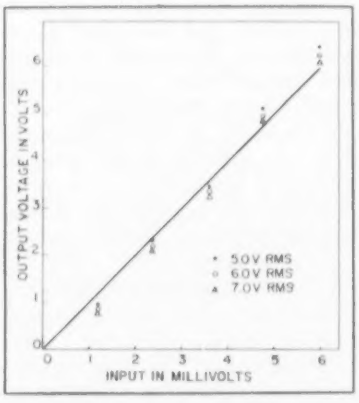


FIG. 4—Chopper drive variation for 5, 6 and 7 volts rms at 400 cps

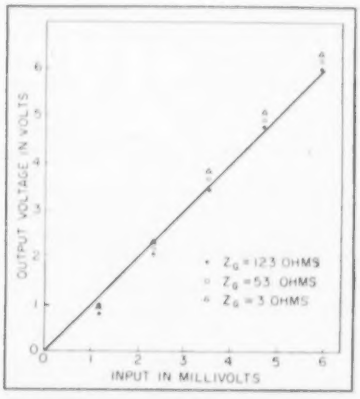


FIG. 5—Generator impedance variation at 3, 53 and 133 ohms

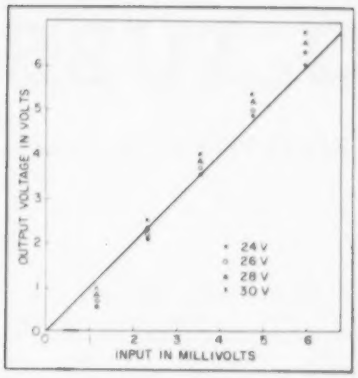


FIG. 6—Power supply voltage variation at 24 to 30 volts

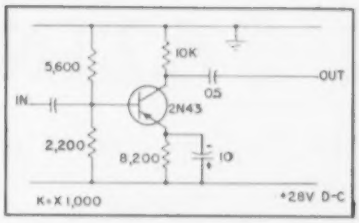
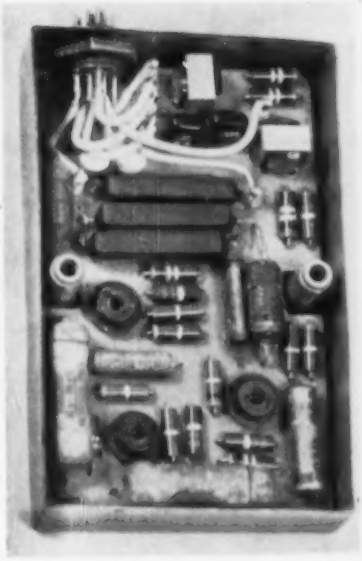


FIG. 7—Typical d-c amplifier circuit. The system employs three iterated common-emitter stages



Compact amplifier unit weighs less than eight ounces. All connections are made to nine-pin connector shown at top left

By JOHN H. PORTER

Portronics, Inc.
Rochester, New York

Uses Transistor Amplifier

±5 percent tolerance on both parameters and d-c between 24 and 30 from a generator or transformer-rectifier combination.

Transistorized telemeters to generate enough r-f power for successful ground station operation still require vacuum tubes in the output stage. This implies a B+ voltage of 180 to 350 or more, as well as a low voltage filament supply, generally and nominally 6.3 at 400 cps.

Vibration surveys within the airframe necessitate a B+ voltage for associated a-c amplifiers. However rapidly advancing transistor development may soon produce a unit whose input impedance is high enough to be compatible with vibration pickups and obviate the need of a plate power supply.

Dissipation of heat is becoming more of a problem and highest possible efficiencies must be sought in the amplifier. Other major problems are space limitations and vibration isolation facilities.

All of these considerations, resulted in the development of a transistorized adaptation of a full-chopper amplifier having a linearity of 2 percent or less over full output range and stability of less than 2 percent change in characteristics in an environment of up to 10 g vibration at 1,000 cps, or over the temperature range from −65 C. to +85 C.

System Chosen

The block diagram in Fig. 1 shows the transistorized system adapted from the full-chopper d-c amplifier in Fig. 2. Typical performance of the system is shown in Figs. 3 through 6.

The chopper portion employs two surface barrier transistors in the grounded-collector configuration. Matching of chopper units was found necessary; however 20 pairs were obtained from a random lot of 50 transistors, by selecting a pair for equal emitter currents.

Chopper output is a particularly clean square wave with no switching transients, as it alternately connects the amplifier input to the signal source and to ground.

Input impedance appears to be a minor function of generator impedance but for source impedances of up to several hundred ohms is in the vicinity of 2,000 ohms.

Overall open-loop gain of 100 db is realized by the amplifier, which consists of three iterated common-emitter stages.

A typical stage is shown in Fig. 7. Component values produce a stability factor $S = 1.1$ and each stage is designed to operate with 10 volts at 1-ma collector current. To provide partial isolation against variations in power supply impedance, a decoupling filter is used in the supply to the first stage. Output of the third stage is capacitively coupled to a voltage doubling rectifier circuit, using miniature selenium diodes, permissible in this application due to the high load impedance and is smoothed by a capacitive filter. The output return is common to the negative of the 28-v supply.

Efficiency of such a network is nearly as high as that of a synchronous demodulator and is considerably more economical of transistors and other components.

NOISE GATING TUBE

By JOHN G. SPRACKLEN, WALTER J. STROH and GEORGE C. WOOD

Zenith Radio Corp.
Chicago, Ill.

General Electric Co.
Owensboro, Kentucky

SUMMARY — Single miniature tube performs entire functions of sync clipping, generating age voltage and giving high degree of noise immunity to both these sections of a television receiver. Type 6BU8 contains common cathode, grid and screen with separate plates and number three grids

NOISE GATING — discriminating against noise pulses on the basis of their amplitude—is combined in the system to be described with a good sync clipper and age circuit in simple form.

Unprotected Circuit

The effect of impulse noise on automatic gain control and sync separating circuits can best be considered by first examining a simple unprotected circuit such as that of Fig. 1. One triode is employed as a self-biased sync clipper. Another triode is used for automatic gain control of the r-f and i-f amplifiers of the receiver in response to the output of the video amplifier.

The video amplifier output has positive-going syncs and includes the d-c component of the composite video signal. A portion of this output is applied to the age tube grid, by a resistive divider. The grid is biased beyond cutoff by the positive potential of the cathode. The age delay control setting determines the level at which the video amplifier output will stabilize.

A resistive divider between anode and a high negative supply of 75 volts provides zero or a slightly positive voltage at the age output and establishes the no-signal anode potential. With signal the anode draws current, its d-c potential falls, causing the age control point to go negative and thus reduce the receiver gain. The positive-going sync pulses of a signal of moderate strength extend to about the center of the grid-control characteristic.

A portion of the video output is applied through a coupling capacitor to the grid of the sync clipper triode. The sync output amplitude is limited by the low plate voltage provided. The depth of clipping is determined by the grid leak resistance and by the amplitude of the applied signal. The clipped sync output goes through suitable networks to the vertical and horizontal synchronizing circuits.

Noise will cause havoc in such an unprotected circuit. Noise pulses are generally of greater amplitude than sync pulses and produce plate current pulses over twice as large as the sync pulses; they can bias the age severely.

In the sync clipper output the noise pulses are as large as the sync pulses. With high noise levels the grid coupling capacitor may charge up and cause complete loss of sync for a period following a noise pulse until normal bias is restored.

One system that has been used with reasonable success to reduce the effect of impulse noise is the

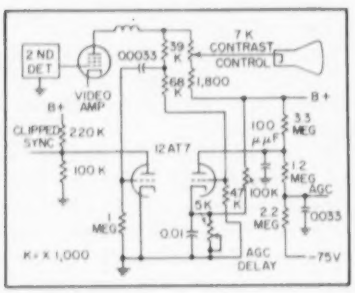


FIG. 1—Simple unprotected circuit for age and sync separation

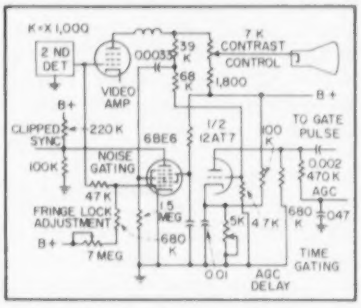


FIG. 3—Triode clipper replaced with pentagrid tube in amplitude gating

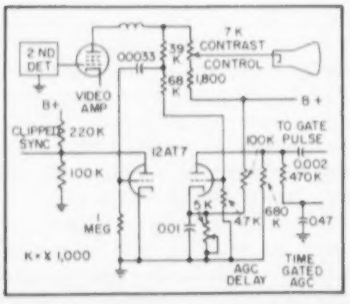


FIG. 2—Impulse noise is time gated but vertical sync output suffers

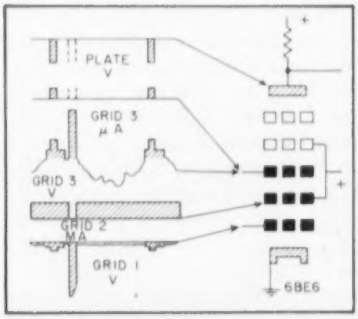
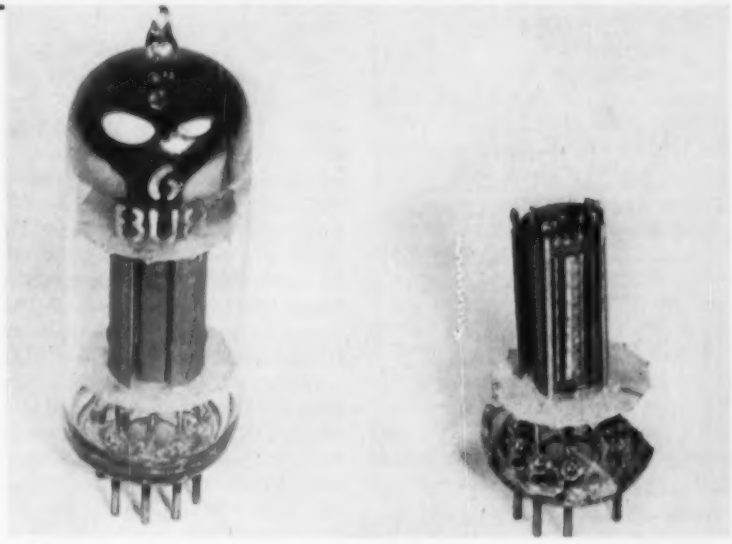


FIG. 4—Relationships at various tube electrodes for circuit of Fig. 3

for AGC and SYNC



New type 6BU8 tube (left) shows two separate anodes. Shield and third grid structure are visible in stripped-down version removed from envelope at right

time gated agc shown in Fig. 2. Time gating means turning the agc tube on only during the brief interval when it is needed. Since the triode must conduct current only during the horizontal sync pulse, it is turned on a short period before the occurrence of the sync pulse and turned off soon afterwards.

This action prevents any anode current in response to noise for the periods between gating intervals. Since the gate pulse is taken from the horizontal sweep circuits, these circuits must be in synchronism before the agc can produce the proper receiver gain and contrast level. In the circuit shown in Fig. 2 the triode is operated as a gated diode, with the agc voltage produced by rectification of the gate pulse.

Such a circuit gains a certain degree of noise protection for the agc. But for the sync clipper, time gating proves impractical. Vertical sync output would suffer. Pull-in of the horizontal sweep would be slow, since until synchronism is established there is no output.

If time gating is not suitable for a sync clipper circuit, amplitude gating can prove useful. Noise pulses, if they are large enough to impair reception, generally show a greater amplitude than the sync tips and a number of circuits have been devised to utilize this difference.

In Fig. 3 the triode clipper is replaced with a pentagrid tube such as the 6BE6. The sync clipper grid is grid 3. The anode is operated

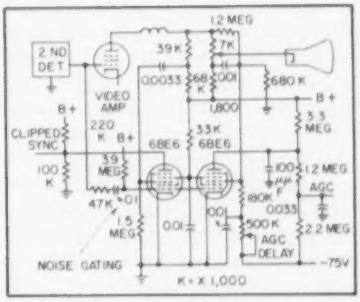


FIG. 5—Second type 6BE6 pentagrid tube is added for agc amplifier

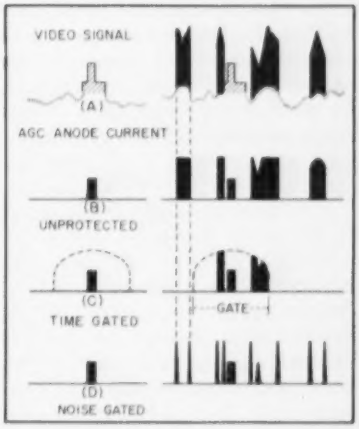


FIG. 6—Comparison of various gating systems in presence of noise

at a low voltage through a resistive divider to limit the sync output amplitude. The output of the second detector is applied through a 47,000-ohm series resistor to grid 1.

This grid is made to operate near zero bias by connecting it through a high resistance to a positive potential. As a result, considerable grid current flows, reducing the resistance between grid and cathode to a few thousand ohms. Video and sync portions of the signal, applied through the 47,000-ohm resistor, are nearly shorted out and have little effect on the anode current.

During negative noise pulses, however, the grid current is reduced to zero, the short-circuit is removed and a pulse of sufficient amplitude will easily cut the tube off as indicated in Fig. 4. A positive replica of a noise pulse appears simultaneously at the clipper grid 3 but it is rendered harmless since there is no current available for the duration of the pulse.

Strictly speaking, a slight disturbance may come through, because noise pulses do not rise or fall with infinite speed and there is an intermediate region where grid 3 is

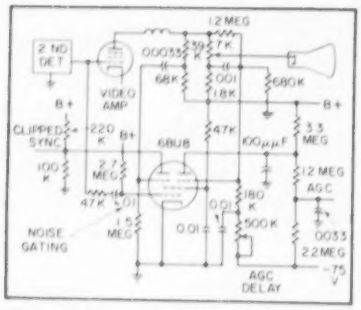


FIG. 7—New type 6BU8 tube simplifies circuit shown in Fig. 5

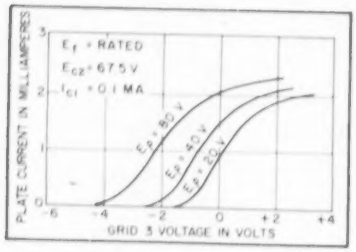


FIG. 8—Average plate characteristics for one section only

already turned on and grid 1 not yet cut off. For this reason a brief transient appears at the beginning and at the end of each noise pulse. In practice these transients are too short to cause significant harm.

Fringe Signals

For maximum noise protection noise pulses should be gated out slightly beyond the sync tips. The gating level is made adjustable by the so-called fringe lock control, which varies the amount of grid current flowing into grid 1. For weak fringe-area signals maximum protection is desired; this corresponds to a maximum resistance position of the control.

However, for moderately strong signals, such a setting gives rise to an instability that has been dubbed split-phase hang-up. To avoid this, the noise gating level must be raised somewhat, corresponding to a lower resistance position of the fringe lock control.

Split-phase hang-up can be traced to the use of an amplitude-gated sync clipper in combination with a time-gated automatic gain control. For example, if the channel selector is switched from a weak to a strong signal, the agc and clipper circuits will sometimes find a stable condition where the picture is split; the horizontal syncs appear as a black stripe near the center of the picture and the contrast level is too high. This occurs when, at the instant of switching, the horizontal sweep is about 180 deg out of phase.

Since no agc bias level has been built up, the signal gain is quite high. This causes the sync clipper to treat the sync pulses like noise pulses and gate them out. Around the center of the horizontal period, some portion of the video may cause the clipper to conduct and produce output. The horizontal frequency control system accepts this output as sync pulses and becomes synchronized in an out-of-phase condition. This causes the time gate for the agc to continue in the wrong phase—thus suppressing the real sync pulse.

Hang-Up

The signal level then stabilizes at a point where the video portion previously mentioned is raised to the level where the sync tips should be. This finally perpetuates the condition that started it all—the gain is so high that the sync tips are treated like noise pulses.

This chain of errors cannot occur with weak signals, because even a slight agc voltage tends to push the video level down low enough. In areas where all signals are weak the control may thus be set for maximum protection. But where stronger channels exist, it must be set to accommodate the strongest.

In Fig. 5 a second 6BE6 pentagrid tube is added for use as agc amplifier. The time gating is removed and the anode is then connected, as in the original d-c circuit, through a network to a high negative supply point, so the agc take-off point is at zero or slightly positive potential for no signal. The first grid, screen and cathode are in parallel with the sync clipper tube. This provides the same noise gating for both circuits.

Since it is desirable to get high d-c gain for the agc, the cathode is grounded. This allows the anode to operate at a lower potential with less dividing-down in the output coupling network. The agc control grid is biased negatively with respect to ground to be beyond cutoff for the no-signal condition. It is accomplished by returning a high resistance divider network to a high negative supply point.

A variable portion of the divider resistance is used to set the bias level and becomes the agc delay control. This is set for the desired contrast with a fairly strong signal. The divider resistance must be high to prevent excessive loading of the negative supply that in practice is derived from the bias developed across the discharge tube grid resistor.

To prevent the loss in high response caused by coupling the video anode to the grid through a high resistance, a small capacitance connects the grid to the junction between the minimum contrast resistor and the contrast control. For best operation the ratio of a-c and d-c components on the agc grid should be about unity.

In the sync clipper circuit, the fringe-lock control has been eliminated. In the absence of time gating in the agc the conditions for split-phase hang-up no longer exist. The grid resistor can therefore be chosen for best noise protection. Also, a coupling capacitor has been added between the second detector and grid 1. This is necessary to prevent the detector from ever biasing off the agc circuit for any extended period.

Advantages

With this new circuit, an improvement in agc performance is noticed, particularly under heavy noise conditions. Strong interference does not back off the agc as much as it does when time gating is used; some types of noise actually deprive the agc anode of current. When this happens, the negative control voltage drops and the signal becomes stronger, an effect that is beneficial in maintaining synchronism and apparent contrast under adverse conditions. Moderate to weak noise pulses are gated out cleanly whereas with time gating the anode would receive extra current during the entire gate periods.

Figure 6 illustrates the difference

between the results of time and amplitude gating in the agc. Line (A) shows the original signal, clean on the left and with various levels of impulse noise on the right. Line (B) shows how in an unprotected agc large currents are produced by each noise pulse. In line (C) a large percentage of the noise current pulses has been eliminated. But the largest improvement appears in line (D) where only a few transients reveal that there was any noise present in the input.

It was questionable whether pentagrid tubes were essential for this circuit. High plate impedance seemed unnecessary. Dual control tubes with only three grids such as the 6AS6, or some experimental pentodes with lower current and suitable grid characteristics, built for the specific purpose, served just as well. These considerations led to the development of the 6BU8, which combines in one structure the functions of these two dual-control pentodes.

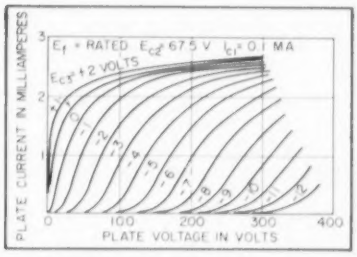


FIG. 9—Average plate characteristics (one section) with plate voltage plotted as abscissa

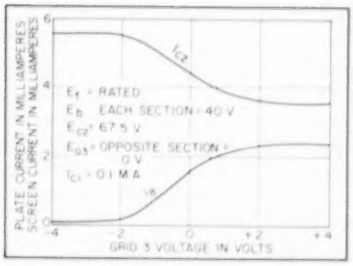


PLATE CURRENT IN MILLIAMPERES
SCREEN CURRENT IN MILLIAMPERES
E_f = RATED
E_b EACH SECTION = 40 V
E_{c2} 67.5 V
E_{c3} OPPOSITE SECTION = 0 V
I_{c1} = 0.1 MA
GRID 3 VOLTAGE IN VOLTS

FIG. 10—Average transfer characteristics for one section of 6BU8 tube

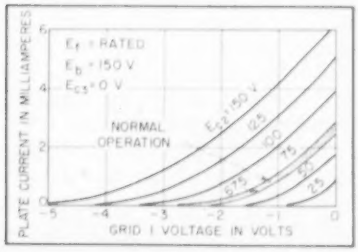


FIG. 11—Plate current plotted against grid-1 voltage shows transfer characteristics of the new tube

Because of the common gating requirement for both circuits the cathode, grid and screen are made one structure in the 6BU8. The third grid and anode have been split and are positioned on each side of the screen. The two halves have identical characteristics. Grid 3 and anode on one side serve the agc and on the other side serve the sync clipper.

Alternatively, the second control grids might also be common. Both grids require a similar composite video signal. If conditions could be so arranged that, when the sync tips extended about to the center of the transfer characteristic of the agc side, peak anode current flowed on the sync clipper side, then such a circuit would work.

It would require, however, that the bias on grid 3 be lowered under extremely weak signal conditions; otherwise the syncs would be lost completely. This would require some carefully designed automatic bias correction, which is not easily found. An expensive alternative would be to increase the i-f gain to a point where the peak video output could be maintained all the way down to the noise level.

A self-biased sync clipper, on the other hand, easily provides sync output down to the very weakest signal; thus there is considerable advantage in keeping it divorced from the agc.

The circuit shown in Fig. 7, using the new type 6BU8, has been used successfully in production sets.

A time-gated agc tends to obstruct horizontal pull-in if it responds too fast. This effect does not apply here and a time constant shorter than usual can be used, making the sets unusually resistant to rapid fading and airplane flutter.

Tube Characteristics

In the new tube two separate electron streams leaving the cathode may pass through grids number 3 to each of the plates. As grid 3 of either section is made negative, the anode current of that section is reduced and the unaccepted current returned to the screen grid and the shield. The two halves operate independently of each other except for grid 1 and screen grid.

A shield being connected to the screen grid has a threefold purpose. It prevents electrons from flowing around grids 3 to the anodes, it catches the electrons that might otherwise bombard the bulb and it prevents occurrence of Barkhausen oscillations.

Figure 8 represents the plate characteristics for either section plotted against grid 3 voltage. The agc section of the tube normally operates with low plate voltage, not far from 20 volts; however, the sync clipper section may work with higher voltages on the plate. Curves are shown for 20, 40 and 80 volts.

A video signal with sync pulses going toward the right, increases the plate current to the maximum level, producing only the sync pulse in the output. In the agc section the sync pulses extend to about the center of grid 3 control characteristic.

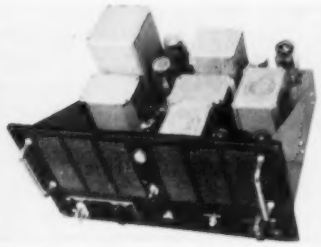
Essentially the same information is shown in Fig 9 except plate voltage has been replotted on the abscissa.

Negative Grid

What happens to the electron streams when grid 3 is made negative to block the flow of plate current is shown in Fig. 10. Most, if not all, of this current appears on the screen and shield so that a negative transconductance exists from grid 3 to these electrodes. Since the screen is common to both sections, the effect of both grids 3 shows up simultaneously in the screen current.

Figure 11 shows how the plate current in either section is controlled by the voltage on the first grid. In normal operation the screen is at about 70 volts and grid 1 is at about zero volts. A noise pulse of about −2.4 volts will cut off the tube entirely.

The writers acknowledge the help of W. T. Millis and Claude Hopper, Jr. of the Tube Division, General Electric Co., and of Robert Adler of Zenith Radio Corp.



Chassis of 90-watt power amplifier indicates the simplicity and economy of construction, made possible because of the limited frequency applications

Laboratory oscillator connected to the 90-watt power amplifier provides drive signal for testing transformer on the right

POWER AMPLIFIER

By JOSEPH M. DIAMOND

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New York, N. Y.

SUMMARY —— Economical design of efficient oscillator-driven power amplifier uses pentode cathode follower to supply 90 watts at 400 to 2,600 cycles for testing aircraft and shipboard servo systems. Regulated bias and screen voltages permit stable output independent of line fluctuation

WIDESPREAD use of 400 to 2,600-cycle power in electronic equipment has raised a problem of supplying this power for testing transformers, magnetic amplifiers, servo devices, circuits and complete pieces of equipment. Since rotating machines have a number of disadvantages, a power amplifier was designed to produce 90 watts in the frequency range of interest, driven by a laboratory oscillator.

The specific requirements of this application have led to a specialized and unusual design. Since a substantial power output is required, efficiency is a prime consideration. Therefore, a true pentode output connection is desirable, rather than a triode or intermediate, screen-tap, connection.

The pentode connection of most beam power tubes is also preferable, in that higher plate voltages are permitted. Other requirements are good waveform and good regulation, which means that a substantial amount of feedback is involved.

Cathode Follower

These considerations suggest a cathode-follower output stage. Figure 1 shows how an output transformer with two identical, interleaved 500-ohm windings permit true pentode cathode-follower operation, since the screens are exactly in phase with the cathodes. The screen-cathode bypass capacitors maintain this condition at high frequencies, and equally important, they effectively parallel the windings over the whole frequency range, thus reducing both copper loss and leakage reactance. The commercially available transformer used is intended for line-to-line-to-voice coil use and is rated only 20 watts for the full audio band. Since the present application does not require frequencies much below 400 cps, it is permissible to raise the voltage applied to the 500-ohm windings from the normal rating of 100 v rms to the 650 v rms required by this output stage, without core saturation.

The distortion curves, Fig. 2, show that full power is available down to 150 cps. The nominal 20-ohm output tap is then convenient for 117-v output, though other taps may be used, depending upon the voltage and power required.

Aside from the screen problem, the usual difficulty of the cathode-follower power stage is the driving voltage required. In this case, the restricted frequency range permits a small output transformer to supply the necessary 350-volts rms to

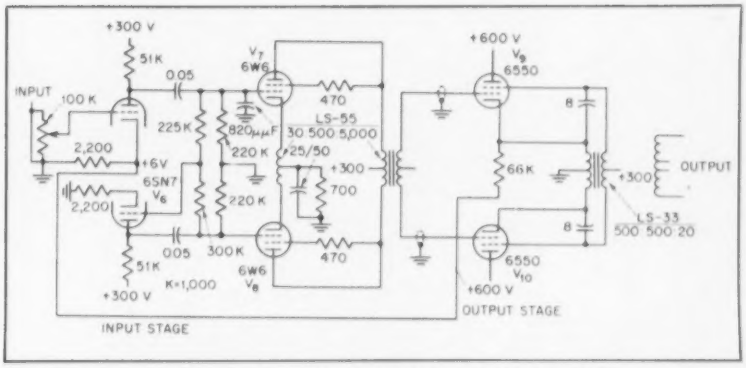

FIG. 1—Output transformer with two identical, interleaved 500-ohm windings permit true pentode cathode-follower operation, since the screens follow in exact phase with the cathodes. Bypass capacitors maintain this condition at high frequencies

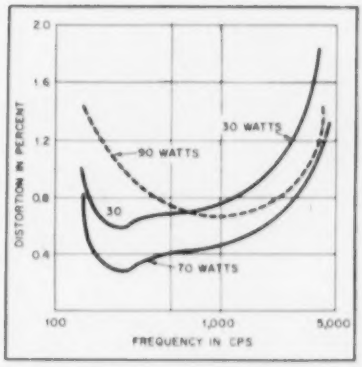

FIG. 2—Distortion curves were taken at 117-v output, using the 20-ohm output tap. Performance shows frequency response

FOR SERVO TESTING

each output grid. A pair of 6W6-GT's, triode connected, drive the usual 500-ohm winding of the transformer, while the 5,000-ohm plate winding is used for the output, achieving a 3.2-to-1 step-up. The 30-ohm winding provides local feedback to the 6W6 cathodes to reduce distortion and extend the frequency response.

Thus the limited frequency range of the application permits a simple, economical design which is adequate for the given requirements, but which would be much less practical for the full audio band. Performance is indicated by the distortion curves shown in Fig. 2, which were taken at 117-v output, using the 20-ohm tap.

Power level was varied by changing loading. Under these conditions, hum is 70 db down, frequency response is flat and regulation is 4 percent from no load to 70 watts.

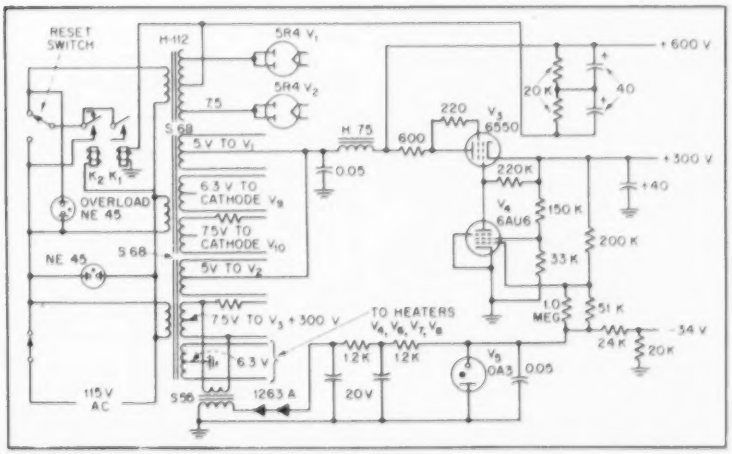

FIG. 3—Power supply for the 90-watt power source. Supply used for the final screens maintains constant screen voltage with a highly variable screen current

Power Supply

The regulated power supply, shown in Fig. 3, used for the final stage screens, maintains constant voltage and also supplies the lower level stages without the necessity of decoupling.

The regulator circuit is controlled by the regulated bias source, so that both bias and screen voltage are proportional to v-r tube voltage. This permits fixed resistors to be used in the regulator circuit, while allowing for a reasonable variation of v-r tube voltage.

Since the pentode cathode-follower output stage is highly immune to variations in plate supply voltage, the result of regulating the bias and screen voltages is to make the amplifier output independent of moderate line fluctuations.

An overload relay in the final plate supply protects the output stage from excessive loading and dissipation. The reset circuit is arranged to prevent chattering.

Smiling face produced on screen of standard oscilloscope

Cutouts added in advertising display based on face generator

TRISTABLE GATE MOVES

By PAUL A. RYAN

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Columbus, Ohio

ELECTRONIC circuits are used to generate waveforms such that when applied to the vertical and horizontal deflection amplifiers of any conventional oscilloscope, the resulting trace has the appearance of a comic face. Potentiometers control the features of the generated face to make the lips smile, frown or move, assimilating an actual conversation. The relative position of each component of the face can also be adjusted.

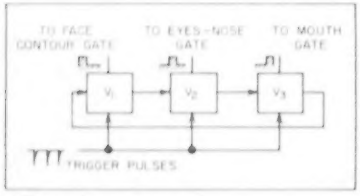

FIG. 1—Diode gating circuit

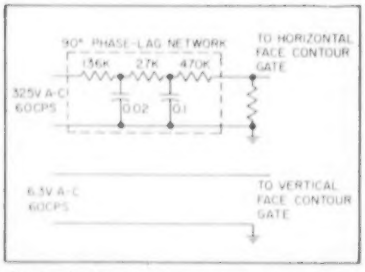

FIG. 2—Generation of face contour signals

Circuit Description

Two generators form the elements of the face; one generator forming the outer ellipse or contour of the face and the other generator forming the mouth. The eyes and nose are created by properly locating the electron spot on the oscilloscope screen. Diode gating circuits operating in conjunction with electronic switching circuits alternately display each element of the face.

Initially the face contour gate is opened and the electron spot on the oscilloscope follows an elliptical path. It requires 1/60 second for the spot to traverse the elliptical path once. The face contour gate is therefore held open by the electronic switch for 1/60 second. During one-fourth of this time interval (1/240 second) the electron spot is positioned to form the eye on the right of the screen and during the next 1/240 second the spot is rapidly moved to a position to form the other eye. The remaining time (1/120 second) of this gating period is required for the spot to form the nose.

The face contour gate is closed and the eyes-nose gate is opened for a period of 1/60 second.

The eyes-nose gate now closes and the mouth gate instantly opens. The mouth generator has a period of 1/60 second; that is, it

Table I—Initial Adjustment

R_2—Adjust for horizontal centering of the mouth within the face contour
R_1—Adjust for proper vertical position of mouth within face contour
R_5—Adjust for proper vertical distance between the nose and eyes
R_7—Adjust for proper horizontal distance between the nose and the eye on the left hand side of the screen
R_6—Adjust for proper horizontal distance between the two eyes
R_4—Adjust for horizontal centering of the eyes and nose within the face contour
R_3—Adjust for proper vertical centering of the eyes and nose

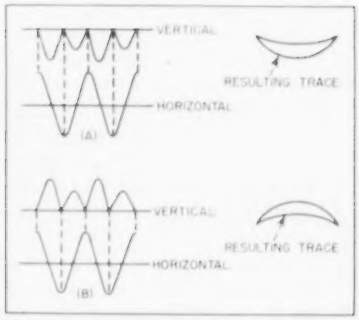

FIG. 3—Mouth generator waveforms, smiling (A) and frowning (B)

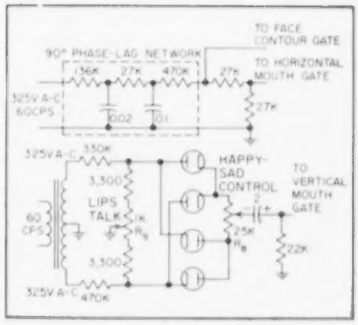

FIG. 4—Circuits for generating mouth contour

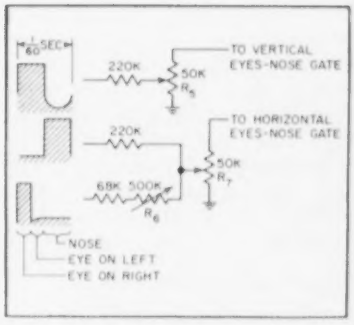

FIG. 5—Method of generating eyes and nose

SUMMARY —— Wave forms applied to deflection circuits of a conventional oscilloscope produce visual patterns, such as alphabets and textile designs. Useful in entertainment and advertising fields is device generating curved contours and appropriate gates to form a mobile face

CRO LINE DRAWINGS

requires 1/60 of a second for the electron spot to trace the mouth contour a single time. By successive repetition of the above process, the face is formed on the oscilloscope screen.

Figure 1 illustrates the operation of the diode gating circuits. If the electronic switch increases the anode potential of one of the diodes to a value greater than the anode potentials of either of the two remaining diodes, then only the diode having the highest anode potential will conduct. As a result, the output signal will vary in accordance with the signal voltage associated with the conducting diode. In this manner the desired signal voltage is selected.

Contour Generators

The elliptical face contour can be formed by applying two sine waves, displaced by 90 deg, to the vertical and horizontal amplifiers of the oscilloscope. These signals are derived directly from the 60-cycle power line source as shown by Fig. 2.

If a rectified sine wave is applied to the vertical amplifier and a sine wave shifted by 90 deg is applied to the horizontal amplifier of the oscilloscope, the resulting pattern will have the appearance of a mouth. Such waveforms together with the resulting patterns are illustrated in Fig. 3.

The alternate cycles of the rectified waveform have different peak amplitudes that result in two traces representing the upper and lower lips of the mouth. The polarity of the rectified waveform determines whether the mouth is smiling or frowning.

The circuits for generating the mouth waveforms are shown in Fig. 4. Each waveform is again derived from the 60-cps power-line source. The status of unequal alternate amplitudes of the rectified waveform is accomplished by the asymmetrical voltage dividers supplying signals to the diode rectifiers. The 1,000-ohm control in the circuit varies the symmetry of the voltage dividers and thereby varies the distance between the upper and lower lips.

By varying this control, the face can give the appearance of talking. The 25,000-ohm control is bridged between the two rectified waveforms having opposed polarity. Adjustment of this control determines the degree of which the lips are smiling or frowning.

The 90-deg signal required for the horizontal amplifiers is derived from the same phase-lag network used in forming the face contour. A voltage divider is used between the face contour and mouth circuits following the 90-deg phase-shift network that fixes the width of the mouth at one-half the width of the face.

The waveforms used to trace the eyes and nose are shown in Fig. 5. The generation of these waveforms will be explained later since they are closely associated with the operation of other circuits.

Tubes V_1, V_2 and V_4 shown on the block diagram (Fig. 6) form the

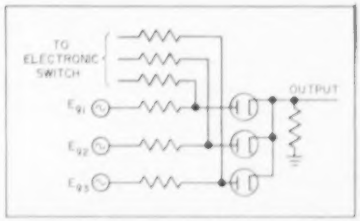

FIG. 6—Connection of tristable switching circuit

electronic switching circuit that is used alternately to open and close the three gates. This circuit consists of three bistable flip-flop circuits that are coupled into a closed ring. The three flip-flops are interconnected in such manner that only one (B) section (the right-hand section) of the three tubes can be nonconducting at any time.

Gate Operation

The plate potential of the nonconducting right-hand section will exceed the plate potentials of the other two right-hand sections by approximately 75 volts. Since the three right-hand sections of the flip-flops are connected directly to the three gates, increased anode potential of the nonconducting right-hand section will operate the gate to which it is connected. Since only one right-hand section can be nonconducting at any time, only one gate can be open at any given time.

These flip-flops are triggered at a 60-cps rate by the negative pulses from a trigger circuit. The flip-flops are coupled in such manner that the trigger pulses successively transfer the nonconducting right-hand state around the ring.

Schmitt Trigger

Driven by a 60-cycle sinusoidal signal, the Schmitt circuit produces trigger pulses for the operation of the electronic switch. This circuit also controls waveforms needed for the generation of the eyes and nose. The top waveform shown in Fig. 5 appears at the first anode (left-hand section) of the Schmitt trigger and the second waveform appears at the second anode.

The delay multivibrator is used to produce a positive pulse approximately 1/240 second in duration. This pulse has the appearance of the bottom waveform in Fig. 5 and is used to generate the eye on the right-hand side of the screen. The delay multivibrator is triggered by a signal taken from the cathode of the Schmitt trigger.

The vertical and horizontal output terminals connect respectively to the vertical and horizontal deflection amplifiers of any conventional oscilloscope. After sufficient warm-up of the instruments the pattern on the oscilloscope screen is adjusted for proper centering. Oscilloscope gain is set so no portion of the pattern exceeds the limits of the screen.

The Schmitt trigger sensitivity control R_{10} is adjusted until all the elements of the face are visible on the screen. This control will only have a limited range where all the face elements will appear. With the control set at the middle of this range no further adjustment should be necessary.

A list of the functions of the remaining controls is shown in Table I in the sequence that should be followed for initial adjustment of the electronic face.

The distance between the upper and lower lips give the appearance of talking.

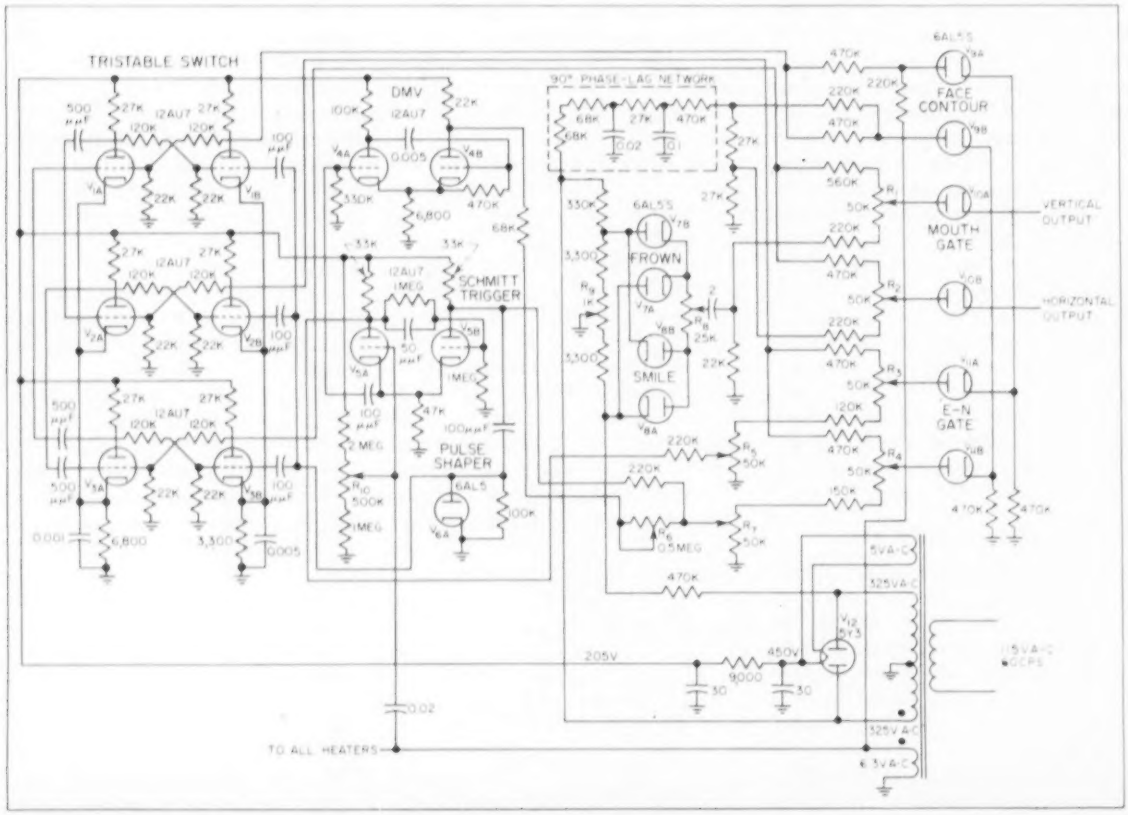

FIG. 7—Schematic diagram of the face generator used with standard oscilloscope

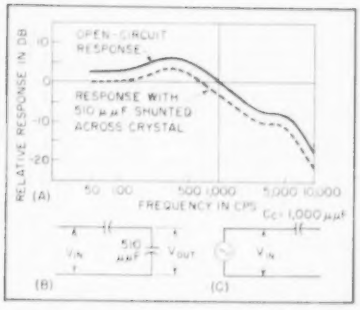

FIG. 1—Crystal response (A) shows effect of capacitive shunt that creates capacitive voltage divider

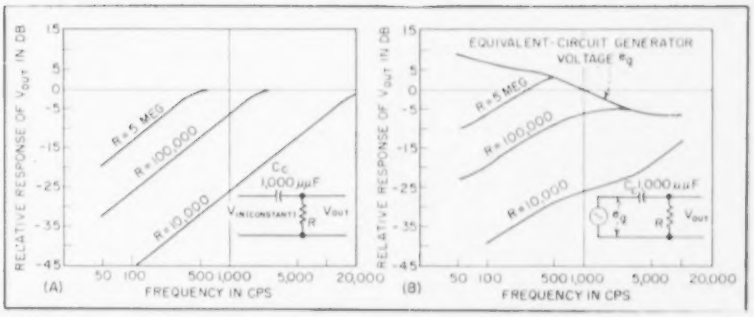

FIG. 2—Network formed when crystal is terminated with resistance and response for constant input voltage (A); equivalent generator circuit of crystal with terminating resistance and response (B)

FLATTENING RESPONSE of CRYSTAL PICKUPS

By A. L. CLELAND*

Radio Corporation of America
Semiconductor Division
Somerville, N. J.

SUMMARY —— Knowing equivalent capacitance and low-frequency limit of crystal phonograph pickup, terminating network can be designed to produce flat frequency response at output. Typical design problem is worked out and application of crystal pickups to transistor amplifiers is discussed

FLAT FREQUENCY RESPONSE can be obtained from a crystal pickup by using a matching network between the pickup and the following amplifier stage. This article analyzes the characteristics of crystal pickups in terms of their equivalent circuits and describes a simple method for designing the required matching network.

General Considerations

The open-circuit response of a typical medium-output crystal pick-up, obtained from a frequency-test record, is shown as the solid curve in Fig. 1A. The dashed curve shows the response obtained when the same crystal is shunted by a 510-$\mu\mu$f capacitance.

The resemblance of the two curves indicates that addition of the shunt capacitor creates a capacitive voltage divider (Fig. 1B). The crystal, therefore, is equivalent to a generator of zero internal resistance in series with a capacitance (Fig. 1C). The 3-db difference between the open-circuit output and the output with 510 $\mu\mu$f of shunt capacitance indicates that the equivalent capacitance of the crystal, including associated stray capacitance, is about 1,000 $\mu\mu$f.

Terminating Resistance

The effect of various values of terminating resistance on the response of the crystal is shown in Fig. 2. Figure 2A shows the resulting R-C network and its response for constant input voltage and different values of R. Figure 2B shows the response when the constant-voltage source is replaced by the equivalent circuit of a crystal having an ideal open-circuit response.

The overall response to the RIAA recording characteristic is not flat and depends upon the value of R. For $R = 5$ megohms, the 3-db bandwidth is approximately 250 to 1,000 cps; for $R = 100{,}000$ ohms, the response with respect to 1,000 cps is down 3 db at 500 cps, but extends through 10,000 cps at the high end; for $R = 10{,}000$ ohms, the response

* Now with Aircraft Radio Corp., Boonton, N. J.

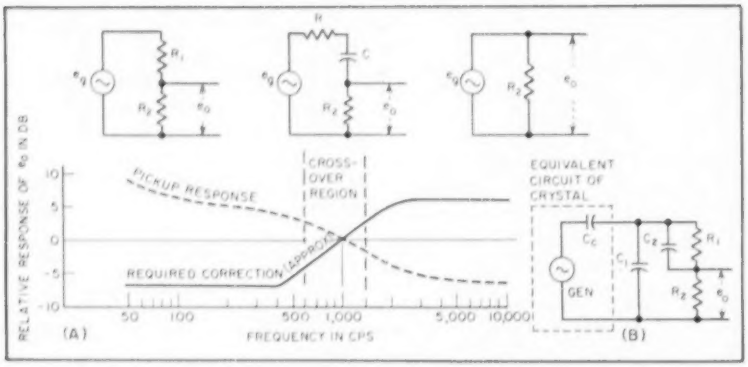

FIG. 3—Networks providing required frequency correction in low, crossover and high-frequency regions (A). Composite network (B) provides all-over correction shown in A

with respect to 1,000 cps is down 13 db at 100 cps and up 13 db at 10,000 cps. For R = 10,000 ohms, the output at 1,000 cps is also 20 db less than that for R = 100,000 ohms.

Network Design

Flat system response is achieved if the crystal is terminated by a network having a response which is the inverse of that of the open-circuited crystal. A response which approximates this inverse characteristic is shown by the solid curve of Fig. 3A. The equivalent network circuits for the low-frequency, crossover and high-frequency regions are shown in the inserts.

In the low-frequency region, the termination must appear to be a resistive divider such that the output voltage is 13 db below the generator voltage. In the crossover region the termination must appear to be an R-C combination such that the output has a positive slope of 6 db per octave. In the high-frequency region the termination must appear to be a resistance such that the output voltage is equal to the generator voltage.

Figure 3B shows a circuit which, with the proper parameters, will provide the type of response described to a good approximation. The crystal is terminated in capacitance C_t so that the source seen by terminating network $C_tR_1R_2$ is a generator delivering a voltage directly proportional to that of the equivalent crystal generator throughout the frequency range.

The reactance of C_t in the low-frequency region should be large in comparison to R_1. The equivalent circuit for this region is then a generator delivering an output voltage e_g, terminated by $R_1 + R_2$, which should be chosen so voltage e_o across R_2 is 13 db below e_g.

In the crossover region, the reactance of C_t is no longer large in comparison to R_1 and generator e_g is terminated by the series combination RCR_2. The resulting e_o has a positive slope of 6 db per octave. In the high-frequency region, the reactance of C_t is small in comparison to both R_1 and R_2 and the generator appears to be terminated only by R_2; e_o is essentially equal to e_g.

The requirements of such a network are met if: (1) the reactance of C_1 at the lowest frequency desired is small in comparison to the sum of R_1 and R_2, and C_1 is large in comparison to C_c so normal variations of C_c among individual pickups can be neglected in calculations; (2) the values of R_1 and R_2 are such that at low frequencies e_o is 12 db below generator output e_g; (3) the reactance of C_2 at the 3-db down point of the crossover region is equal to R_2.

Design Procedure

Crystal - terminating networks having the desired characteristics can be designed by the following procedure, if equivalent crystal capacitance C_c and the low-frequency limit f_l are known

(1) Assume a value K for $R_1 + R_2$. Because $X_{c1} \leqq K$ at f_l, $C_1 \geqq 1/(2\pi f_l K)$.

(2) From the measured open-circuit response of the crystal, determine attenuation n in db required at f_l. Then $e_o/e_g = \log^{-1}(n/20)$. Because $e_o/e_g = R_2/K$, $R_2 = K\ [\log^{-1}(n/20)]$ and $R_1 = K - R_2$.

(3) $C_2 = R_1$ at the 3-db down point in the crossover region (≈700 cps).

Therefore $C_2 = 1/[(2\pi)(700)(R_1)]$.

Design Example

As an example, design a network for a crystal having an equivalent capacitance (C_c) of approximately 1,000 $\mu\mu$f and the open-circuit response shown by the dashed curve in Fig. 2B. The low-frequency limit f_l is to be 50 cps and the value of $R_1 + R_2$ is to be 100,000 ohms.

(1) $K = R_1 + R_2$ = 100,000 ohms.

(2) $C_1 \approx 1/[2\pi\ (50)\ 10^5] = 0.0319\ \mu$f.

(3) Fig. 3A indicates that an average attenuation of approximately 12 db is desired in the low-

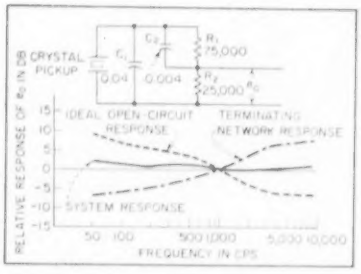

FIG. 4—Calculated parameters of terminating network for RCA 75476 pickup and resulting overall response

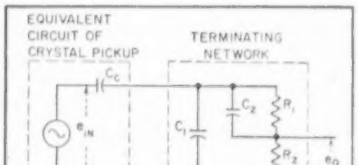

FIG. 5—Derivation of equivalent circuit for crossover region in Fig. 3A

frequency region. This 12-db figure will aid in compensating for crystal and/or stylus resonances. Therefore $e_s/e_g = \log^{-1}(12/20)$; $e_g/e_o = \log^{-1}(20/12) = 4$; $R_2 = K/4 = 100{,}000/4 = 25{,}000$ ohms and $R_1 = 100{,}000 - 25{,}000 = 75{,}000$ ohms.

(4) $C_2 \simeq 1/[2\pi\ (700)\ (75 \times 10^3)] = 0.00304\ \mu f$.

This network and the resulting response characteristics are shown in Fig. 4.

Volume peaks on RCA 45-rpm and long-playing records are recorded at 8 db above average level. Since the average-level 1,000-cps output of the pickup to be used here is 0.7 v rms, the corresponding signal across the 25,000-ohm terminating resistor, R_2, has an average value of 6 mv and reaches approximately 42 mv on volume peaks.

Equivalent Circuit

Figure 5 shows how the terminating network and crystal may be converted by Thevenin's theorem to the equivalent circuit shown above the crossover region in Fig. 3A.

In this equivalent circuit the generator output is attenuated by the amount $C_c/(C_c + C_1)$ and is applied to frequency dependent series network RC and R_2, the load resistance of the terminating network. Resistance R_2 may consist only of the input resistance of the first amplifier stage or include additional resistance elements in series or parallel with the amplifier input resistance. In any case, the effective value of R_2 must be that calculated from the design considerations.

If the network is coupled directly to the input of the first amplifier stage, an additional blocking capacitor should be used in the output lead so that no d-c is applied to the crystal. The reactance of this capacitor at the lowest desired frequency should be not more than one-tenth the value of R_2.

Overall Response

Figure 6 shows the over-all response of a system employing a RCA Stock No. 75476 medium-output pickup, a network of the type

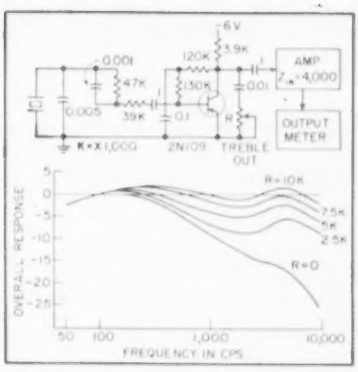

FIG. 6—Crystal pickup is matched through network to transistor preamplifier. Over-all response is shown for various amounts of treble cut

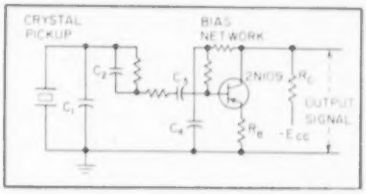

FIG. 7—Degenerative transistor preamplifier has higher input impedance and signal-to-noise ratio, with less distortion, than circuit shown in Fig. 6. Gain, however, is less

described above and a transistor amplifier. The curves include the effects of the RIAA recording characteristic, the crystal, the terminating network and the complete amplifier. They show the response for various amounts of treble cut.

At low frequencies, the effective load seen by the collector of the preamplifier is approximately 3,900 ohms because of the large reactance of the 0.01-μf capacitor, C_3. At high frequencies, however, the collector effectively sees R in parallel with the 3,900-ohm load resistor and the high-frequency response falls off as the value of R is reduced.

The resistance and capacitance values used in the terminating network of Fig. 6 were chosen to compensate for the crystal and/or stylus resonances of a particular pickup and may be quite different when another type of crystal pickup is used.

Thus far system response has been treated in a general manner and no attempt has been made to emphasize the advantages of transistors over tubes as preamplifiers. Transistors, however, have no hum problems, are nonmicrophonic and can provide higher signal-to-noise ratios than tubes.

Transistor Preamplifier

The common-emitter preamplifier stage shown in Fig. 6 has an input impedance of approximately 8,000 ohms and a voltage gain of 60. The crystal-terminating network used for this amplifier has an output of approximately 1.7 mv, so that approximately 102 mv of signal are delivered to the following amplifier stage.

A common-collector preamplifier stage, on the other hand, may have substantially higher input impedance (approximately 100,000 ohms), but a maximum voltage gain of only about 0.9. The voltage output of a crystal-terminating network for such a stage would be about 6 mv and the voltage at the base of the following stage = (0.9) (6) = 5.4 mv, or 96.6 mv less than that for the common-emitter circuit.

Low-Impedance Loads

Another factor requiring consideration is that crystal-terminating networks designed to work into low-impedance load circuits require relatively large capacitance values, adding to their size and cost. Consequently, choice of the best transistor-circuit configuration for a particular application must be determined by the design engineer.

In many cases, a good compromise may be obtained by the use of a degenerative common-emitter circuit such as that shown in Fig. 7. In this circuit the load resistor for the crystal-terminating network is the input resistance of the transistor and is approximately equal to current gain, α_{ce}, of the transistor times resistance R_e in the emitter lead.

Although this circuit has less gain than the nondegenerative common-emitter circuit shown in Fig. 6, it has higher input resistance, a better signal-to-noise ratio and produces less distortion.

VLF OSCILLATOR KEYS

SUMMARY —— Two transistor multivibrators control relay system to key signal generator at either 4 or 6 pps. Either modulation or carrier can be controlled with accuracy of ± 5 percent by simple system requiring only minor modification of signal generator

DEVELOPED to replace an electromechanical keying arrangement, the transistor multivibrator described here drives a grounded-emitter direct-coupled relay amplifier to pulse either the modulation or carrier of a vhf signal generator at very low frequencies. Figure 1 shows pulse widths and repetition rates required in this application.

A transistor multivibrator was chosen for long trouble-free equipment life and the other attendant advantages of transistors, small size, low power needs and low heat dissipation. Type 2N104 junction units were chosen. These are small-signal *pnp* audio-frequency types. The basic circuit developed is shown in Fig. 2.

Operation

Considering Q_1 conducting and Q_2 cut off, C_2 is charged to the supply voltage while C_1 is discharging through R_1. When the charge on C_1 is low enough to allow Q_2 to conduct, the decrease in voltage at the collector will be coupled by C_2 to Q_1.

This will cause Q_1 to conduct less heavily bringing its collector to a more negative value. The action is cumulative and results in Q_1 cut off and Q_2 conducting. At this point the charge begins to leak off C_2 and at the proper point the action repeats itself providing a series of pulses.

The time of discharge of either capacitor, and the resultant off time of the transistor it affects is equal to

$$T_1 = R_1C_1 \log_e \frac{E_u + E_1}{E_u + E_{co}}$$

Where E_u = voltage base resistor R_1 is returned to, E_1 = voltage

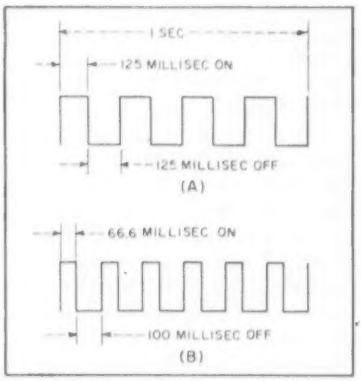

FIG. 1—Pulse times for four (A) and six pps repetition rates (B)

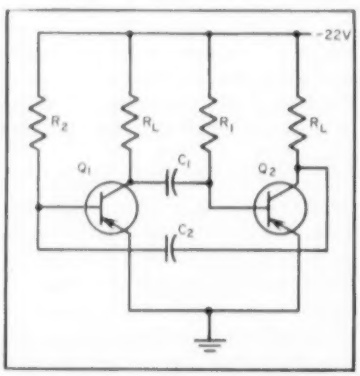

FIG. 2—Basic transistor multivibrator circuit for generator keyer

base must recover from (equal to battery E minus collector E) and E_{co} = voltage level of base when transition occurs. This may be taken as zero.

Twice this time is the total period of a symmetrical multivibrator where $R_1 = R_2$ and $C_1 = C_2$.

For the asymmetrical case, each off time is calculated separately. Emitter resistors were added to provide convenient output points for direct coupling the relay amplifier. If resistors of small value are chosen they raise the natural frequency only slightly and can be neglected in the equation. To achieve the required results and still maintain temperature stability large values of capacitance and small collector and base resistors are required. A compromise was sought that would allow one circuit to produce both of the required outputs with simple resistance adjustments. The arrangement developed is shown in Fig. 3.

Stability Control

Maximum stability is retained by restricting the range of adjustment of the collector load when using it for frequency adjustment. While a ganged potentiometer can be used, fine balance of the transistors is obtained through single unit setting. Symmetry of waveform is controlled by the 100,000-ohm potentiometer in the base return.

These controls allow a minimum of a 2-to-1 frequency range, with

VHF GENERATOR

By LEON H. DULBERGER

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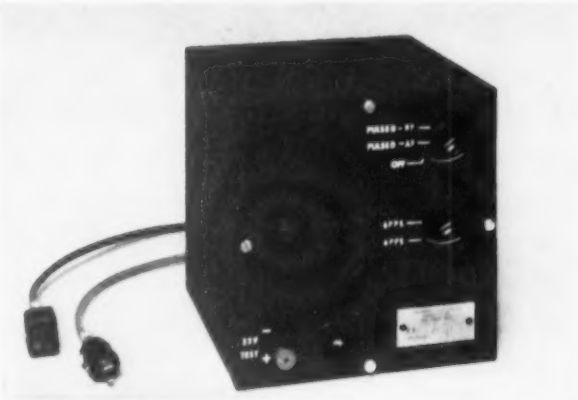

Compact keying unit contains all components except relays, which are mounted in signal generator cabinet

a four-to-one asymmetrical setting, without changing coupling capacitors. Drift of frequency with temperature is ±5 percent. Short-term stability can be improved through the use of temperature controls.

Direct coupling of the output transistor amplifier saves components, and provides sufficient amplification to operate an ordinary 5,000-ohm plate relay. While a small residual current flows at all times through the relay coil, it is below the level that will provide pull-in. A negative voltage applied to the amplifier base initiates a current gain in the output stage closing the relay. The relay contacts pulse the carrier or modulation. All transistors are operated well within their dissipation ratings. Total current drain for each multivibrator-amplifier circuit is about 5.6 ma.

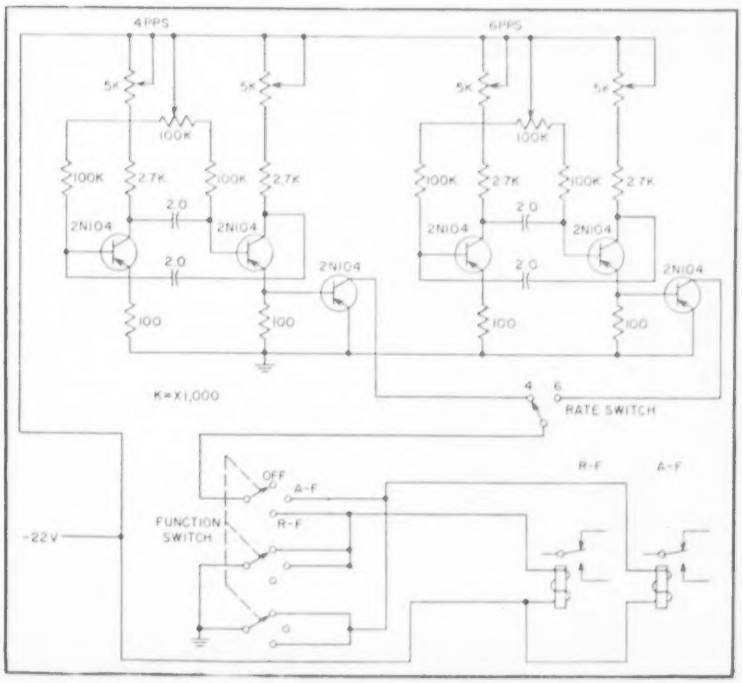

FIG. 3—Transistor multivibrators pulse r-f or a-f modulation at either 4 or 6 pps rate through relays installed in signal generator

Adjustment

Adjustment to either repetition rate is accomplished on a calibrated oscilloscope. The symmetry potentiometer is set midway and the required frequency is obtained by adjusting first one collector resistor and then the other. Symmetry is obtained by balancing the base return.

There is slight interaction between the symmetry control and the frequency potentiometers, but setting is achieved with little effort.

Final adjustment is made on a time-interval meter. The multivibrator not in use is allowed to continue operation to maintain junction temperatures as maximum frequency drift was noted when the circuit was switched on.

The final circuit was adjusted to the relay contact on-off time shown in Fig. 1. This allows relay operate time to be compensated. Packaging was planned to allow the full advantage of the transistor's small size.

Electronic SHUTTER for

By DAVID C. CROCKER

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SUMMARY —— Multivibrators and gates in simple control circuit blank video-recording kinescope during pulldown of film, then allow exactly 525 scanning lines to appear on tube screen for exposure of next frame. Switch on movie camera delivers starting pulse for electronic shutter after each film advance, or 24 times per second. Technique gives one complete tv frame on each film frame despite frame-rate difference

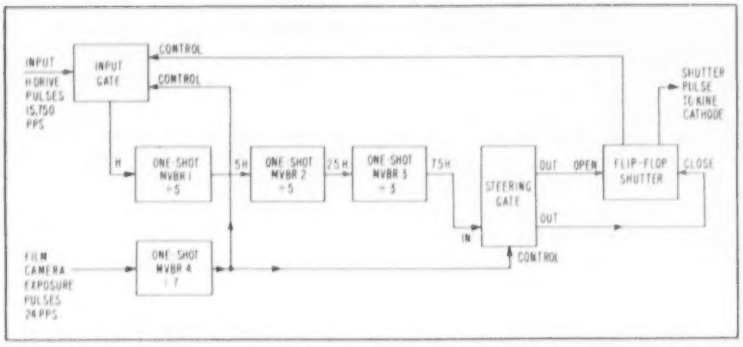


FIG. 1—Pulse from film camera initiates action by unblanking kinescope; multivibrator chain blanks screen after next 525 lines of television picture. Here *H* represents time of one horizontal line of picture

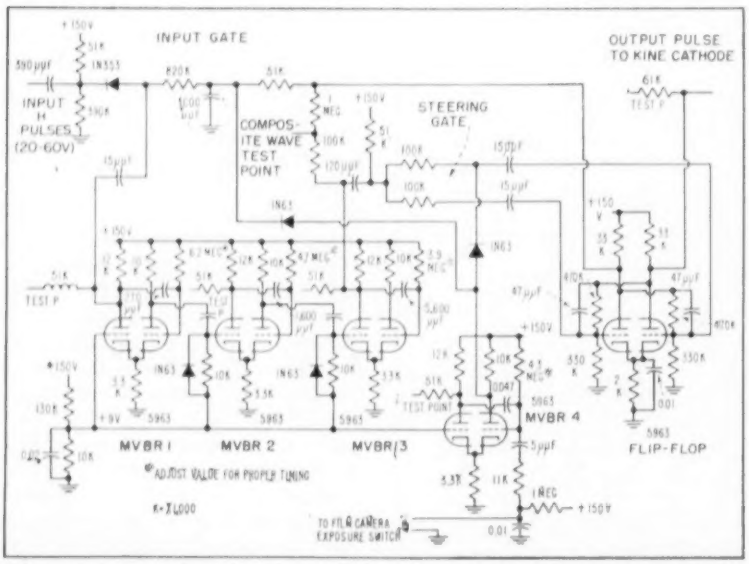


FIG. 2—Experimental version of control shutter. Most studio kinescopes will require additional triode input and output stages

COMMERCIALLY AVAILABLE video recorders with electronic shutters generally use binary counting circuits[1], with a correspondingly large number of stages. Where extreme precision of timing is not a dominant consideration, a simpler arrangement using one-shot multivibrators will often prove equally satisfactory. In breadboard tests, the simpler circuit arrangement to be described fully came up to expectations.

An electronic shutter is desirale for blanking the picture from the face of a kinescope during recorded film pulldown, because it allows an exposure of exactly one complete television frame for each film frame regardless of slight timing differences between the film camera and the television system.

Theory of Operation

The main sections of the electronic shutter are shown in Fig. 1. With no camera exposure pulses coming from the film camera, the input gate is closed, the steering gate directs pulses to the open side of the flip-flop, the four one-shot multivibrators are in their stable positions and the output flip-flop is in the shutter-closed position.

The first film exposure pulse (derived from contacts in the film camera) triggers mvbr 4 to its unstable state. This multivibrator then opens the input gate, allowing the next following horizontal drive or H line pulse to trigger

TV Kinescope Recorder

Breadboard version of electronic shutter under test. Author adjusts audio oscillator to deliver 24-cps signal to squaring amplifier at rear on bench whose 24-cps square-wave output simulates film exposure pulse. Another square-wave generator, on shelf at right, delivers 15,750 pps to simulate tv *H* pulses

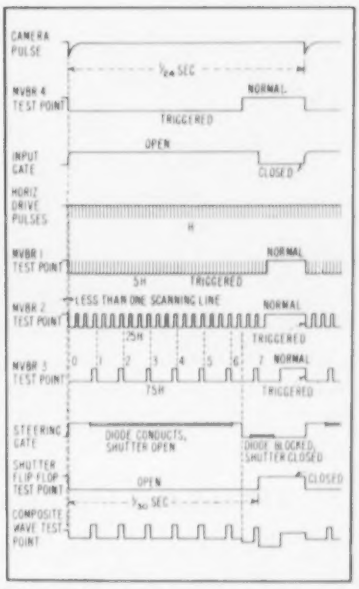


FIG. 3—Waveforms covering time of one horizontal line, one horizontal blanking period and start of next line. Circuit test points are shown in Fig. 2

mvbr 1 to its unstable state. Now mvbr 1 triggers mvbr 2, which in turn triggers mvbr 3, both to their unstable state. The 0th pulse from mvbr 3 is routed through the steering gate to the open side of the shutter flip-flop. This pulse triggers the flip-flop to the shutter-open position and thus unblanks the kinescope.

As long as mvbr 4 remains in its unstable state, subsequent pulses 1 through 6 will be routed to the open side of the flip-flop and will therefore have no effect. The timing of mvbr 4 is such that it will return to its stable state sometime between the 6th and 7th pulses from mvbr 3. This sets the steering gate so that when the 7th pulse arrives, it will be routed to the shutter-closed side of the flip-flop. The flip-flop is triggered to the shutter-closed position and reblanks the kine.

The input gate was opened by mvbr 4 and held open by the shutter-open position of the flip-flop. When the shutter closes, the input gate also closes.

The kinescope was unblanked on the 0th pulse from mvbr 3 and reblanked on the 7th pulse. This means that the kine is unblanked for a period of seven times that of the 75H pulse train from mvbr 3, or 525H—one television frame.

Steering Gate

The circuit diagram of the electronic shutter is given in Fig. 2. Of particular interest here is the steering gate circuit. If the control voltage from mvbr 4 is low (normal state), the 1N63 diode is blocked and the input to the flip-flop is symmetrical. The input pulses will then alternately trigger the flip-flop from open to close and vice versa. If the control voltage is high (triggered state), the diode conducts and blocks all pulses to the shutter-closed side of the flip-flop so that the pulses can only trigger the open side.

Initially the flip-flop is in the shutter-closed position. The 0th pulse from mvbr 3 is supposed to open the shutter. If the diode is conducting, the pulse must go to the open side as desired. If the diode is blocked, the pulse will trigger the flip-flop to its opposite state, so that in either case the shutter opens.

For the 1st through the 6th pulses the diode is definitely conducting, so all pulses are routed to the open side and lost. After the 6th pulse, the diode is blocked so that the 7th pulse will trigger the flip-flop to the shutter-closed position. Waveforms corresponding to this action are shown in Fig. 3 for various points in the circuit.

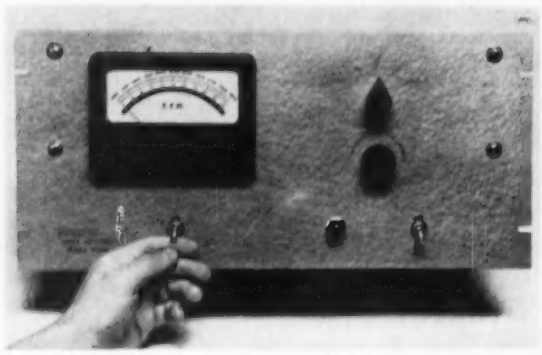
Some studio applications will require use of a preamplifier stage ahead of the electronic shutter to boost the voltage of the control pulses. Here a single triode section will usually suffice.

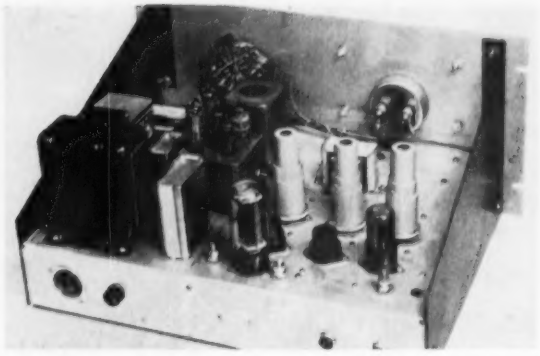
Acknowledgement is extended to Frank W. Harvey, director of engineering at WGBH-TV in Boston, for his encouragement during this investigation.

REFERENCE

(1) F. N. Gillette, G. W. King and R. A. White, Video Program Recorder, ELECTRONICS, p. 90, Oct. 1956.

SPEED INDICATOR





Speed indicating unit (left) is designed for rack mounting. Rear of chassis (right) shows plug-in units for squaring circuit, pulse amplifier and multivibrator at center of chassis. This design reduces instrument-repair downtime

SUMMARY — Multivibrator triggered by shaped signal from a-c tachometer provides speed indication within 1 percent over range from 500 to 5,000 rpm. Regulated bucking voltage provides scale expansion to indicate deviations from operating speed with accuracy of 0.1 percent on 500-rpm full-scale indication

By P. J. POLLARD

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LABORATORY measurement of hydraulic motor speeds requires a method of indicating and recording accurately both the operating speed and deviations from this speed. This is the case in a closed-loop hydraulic servo system where a constant speed is to be maintained under various load conditions. Deflection in the meter.

A speed indicator developed for this purpose provides a means of indicating speed within an accuracy of 1 percent, with expanded-scale deviations as small as 0.1 percent being easily read. The stability and repeatability of an instrument of this type is dependent to a large extent upon plate-voltage regulation on the multivibrator tubes. Use of regulated transformers and electronic regulated plug-in power supplies insures stability.

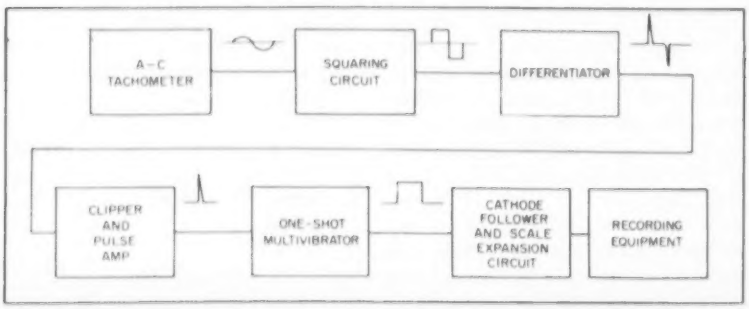

FIG. 1—Block layout of speed indicator, showing waveforms at various points in circuit

Plug-in units are used for the major circuit components. These are the squaring circuit, pulse amplifier, monostable multivibrator and positive and negative regulated power supplies. By using plug-in units, instrument down time is greatly reduced. Detailed service operations are thus confined to the bench and need not interfere with scheduled use of the instrument.

Operation

The block diagram of the speed indicator is shown in Fig. 1. An a-c frequency-sensitive tachometer provides an electrical signal whose frequency is proportional to the

HAS EXPANDED SCALE

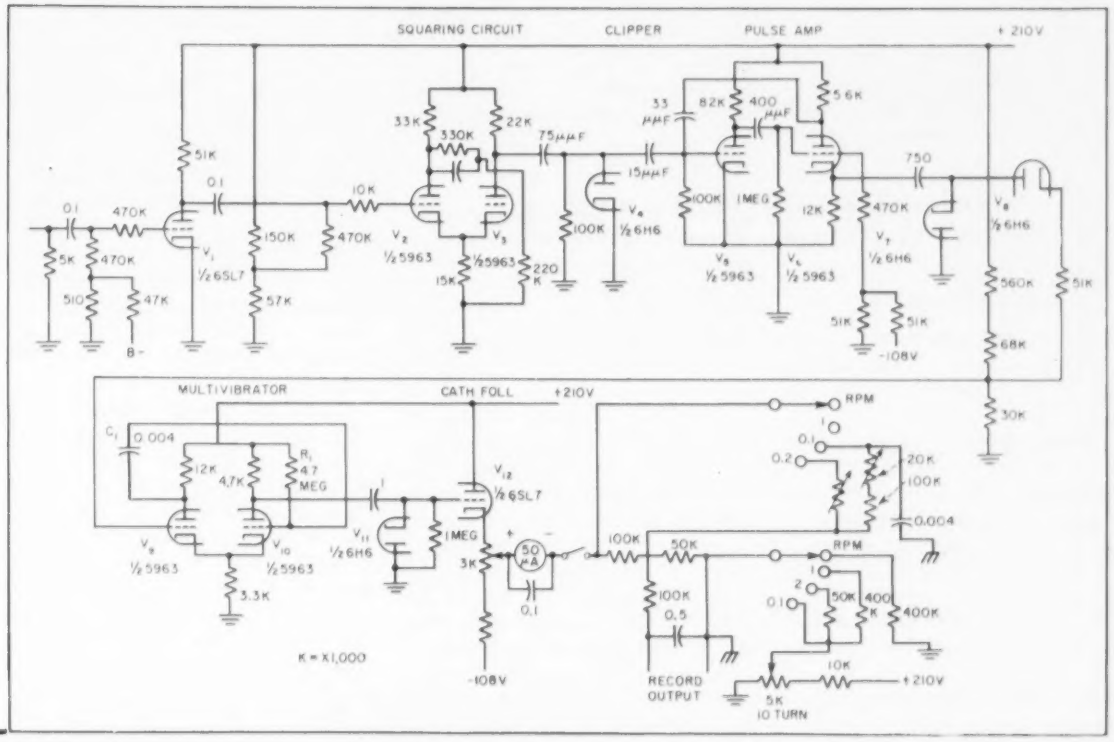

FIG. 2—Squaring circuit, pulse amplifier and multivibrator are constructed as plug-in units for rapid servicing

speed of the system to be measured. This signal is then squared, differentiated, clipped and fed to a pulse amplifier. The output is a pulse of proper amplitude and duration to trigger the one-shot multivibrator.

The multivibrator output is fed to a cathode follower. The final stage consists of a 1-percent accuracy meter, filter circuit and expanded-scale circuit. The expanded scale provides an accurate method of studying small deviations in speed from some nominal value. Two ranges are provided, allowing as small as 10 percent of the main-scale reading to produce full deflection in the meter.

Input Signal

Input voltage may be sinusoidal, triangular or square without affecting the accuracy of the instrument. Likewise, amplitude may vary or be variable ranging from 10 to 100 volts. This makes possible the use of a comparatively inexpensive a-c tachometer to obtain accurate speed measurements.

Wave Shaping Circuit

In the schematic diagram, (Fig. 2), an overdriven two-stage amplifier employing regenerative cathode feedback is used to obtain a square wave from the incoming signal.

This is the key to the versatility of the input signals since the only requirement of the squaring circuit input is sufficient amplitude to drive V_1 into saturation. The resultant waveshape, having a rise time of 2 microseconds, is then differentiated and the negative-going pulse clipped. The quality of the resulting pulse is dependent upon the efficiency of the differentiating circuit and the blocking action of the diode.

To illustrate this more clearly, the operation of the differentiator on the exponent $e^{j\omega t}$ will be considered. The amplitude response of the differentiating circuit

$$\frac{e_o}{e_i} = \frac{R}{R + 1/j\omega C}$$

which may be written as

$$e_o = \left[\frac{j\omega RC}{1 + j\omega RC} \right] e^{j\omega t} \qquad (1)$$

Since the differential of

$$e^{j\omega t} \text{ is } d/dt\, e^{j\omega t} = j\omega e^{j\omega t}$$

Eq. 1 will be proportional to the derivative of $e^{j\omega t}$ if ωRC becomes much less than one.

However, this results in a considerable loss in amplitude response, since RC must be very small in magnitude. For this reason, a pulse amplifier stage is inserted between the clipper stage and the one-shot multivibrator. The result is a pulse of constant amplitude having

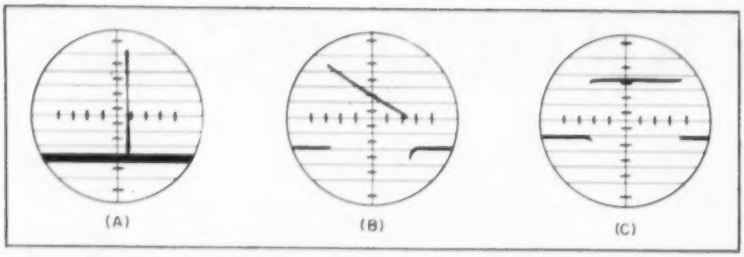

FIG. 3—Triggering pulse (A), time constant (B) and output waveforms of single-shot multivibrator used in expanded scale tachometer

a fixed rise time of 2 microseconds, over a frequency range of 100 to 1,000 cps.

Multivibrator

The multivibrator is triggered by a positive pulse. A stable state, with no input signal, is such that tube V_9 is cut off and tube V_{10} is saturated. Capacitor C_1 has a voltage across it dependent upon the plate-supply voltage and the amount of grid current drawn by V_{10}. A positive pulse, as shown in Fig. 3A, on the grid of V_9 drives that tube into conduction. This pulse must be of sufficient amplitude to produce a positive bias on V_9.

The shape of this pulse must be sharp enough so as to be instantaneously transmitted to the grid of V_{10} from the plate of V_9. Thus, the rise time of the triggering pulse in the coupling capacitor will affect the sharpness of the leading edge of the multivibrator output square wave.

More important is the effect of pulse width on the multivibrator linearity. The optimum 2-microsecond constant-amplitude pulse achieved between the clipper stage and the one-shot multivibrator insures near-perfect output waveshape, hence optimum multivibrator linearity.

The d-c component of the multivibrator triggering pulse is a function of frequency. Therefore, the bias level of V_9 is likewise a function of frequency. When the bias level is shifting, the negative voltage, from which the grid of V_{10} must recover, also shifts.

Waveforms

The oscillogram in Fig. 3B of the V_{10} grid circuit shows that a shift in the voltage level at which the capacitor begins to discharge will have a direct effect on the time required before V_{10} reverts to its steady-state condition. This results in a nonlinear output-versus-frequency characteristic. A change in the triggering pulse amplitude would have the same effect. By narrowing the pulse width to approximately 2 microseconds and controlling the amplitude, any nonlinearity with respect to frequency becomes virtually undetectable.

Power supply fluctuations also have an adverse affect on the accuracy of the multivibrator. This is eliminated by an electronically regulated power supply and a special regulator transformer to minimize the effect of line voltage fluctuations.

A discharge of capacitor C_1 through resistor R_1 may be seen in the oscillogram (Fig. 3B). The instant V_{10} begins to conduct, V_9 is cut off through the regenerative action of the common cathode.

During this time the capacitor must recharge itself. The charging is from the common cathode resistor to the grid of V_{10}, to the capacitor and finally to the plate load of V_9. The forward resistance of the diode action resulting between the grid and cathode of V_{10} produces a small positive voltage on the grid of V_{10}.

Figure 3C illustrates the effect of this voltage on the trailing edge of the multivibrator output square wave. Since this effect is also frequency-sensitive, it must be minimized sufficiently to prevent any detectable nonlinearity in output voltage vs frequency. This may be accomplished by reducing the plate load of V_9 and the common cathode resistor. In this manner, the charge time for the capacitor may be made very short for the lowest frequency to be considered.

Scale Expansion

The expanded-scale circuit provides a well regulated d-c voltage to match the output signal when the selector switch is in position 1. Therefore, any voltage appearing at the cathode of the cathode follower output stage may be matched by the voltage obtained on the arm of the 5,000-ohm 10-turn potentiometer.

If these two voltages are equal, there is no current flow in the circuit between them and the range selector switch may be turned to either of the expanded ranges.

Thus, by manipulating the 10-turn potentiometer in the bucking voltage circuit, any output signal or portion of an output signal may be suppressed. Normally, to use the expanded scale, the initial reading should be reduced to 10 percent of full scale, after which the respective expanded ranges may be engaged. Any commercial recording equipment may be connected to the recorder output terminal.

Applications

In use, the servo system to be tested is brought up to test speed as indicated by the rpm scale. The desired expanded scale is selected and various loads are applied to the system. By utilizing the recorder output jack on the instrument, it is possible to determine how well the system compensates for load fluctuations, the damping factor of the system and other servo design information of similar nature.

The particular instrument described here is the latest of three units that have been built. This model has a range of 500 to 5,000 rpm and will expand any speed within this range to obtain full-scale deflection for a 500-rpm change in speed. Two earlier models were designed for 2,000 to 10,000 rpm and have been used successfully in checking speed fluctuation in an aircraft alternator drive system.

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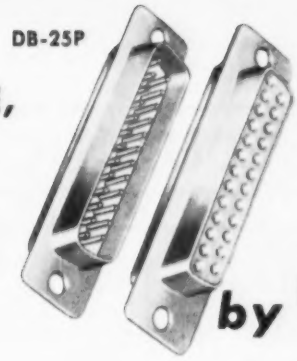

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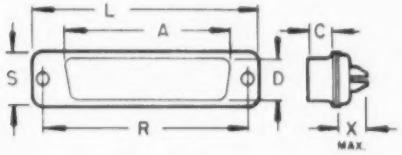

size	A	C	D	L	R	S	X	weight
DA-15P	1 1/64	1 5/64	23/64	1 17/32	1.312	31/64	5/16	.013
DA-15S	1 3/32	1 5/64	5/16	1 17/32	1.312	31/64	5/16	.014
DB-25P	1 9/16	1 5/64	23/64	2 3/64	1.852	31/64	5/16	.023
DB-25S	1 33/64	1 5/64	5/16	2 3/64	1.852	31/64	5/16	.031
DC-37P	2 13/64	1 5/64	23/64	2 33/32	2.500	31/64	5/16	.035
DC-37S	2 11/64	1 5/64	5/16	2 33/32	2.500	31/64	5/16	.035
DD-50P	2 7/64	1 5/64	1 5/32	2 5/8	2.406	39/64	5/16	.035
DD-50S	2 5/64	1 5/64	27/64	2 5/8	2.406	39/64	5/16	.040
DE-9P	43/64	1 5/64	23/64	1 13/64	.984	31/64	5/16	.011
DE-9S	41/64	1 5/64	5/16	1 13/64	.984	31/64	5/16	.012

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More than thirty years experience in the design and manufacture of standard electronic components insure Cannon Connectors by CINCH to be of the highest quality materials, fabricated to specifications to maintain consistent quality of product; highest standards throughout all operations.

D SUB-MINIATURE SPECIFICATIONS:

Shell, including flange — steel or brass; Finish — Cadmium plate or Irridite. Contacts — No. 20, 5 ampere rating — Copper base alloy, gold plate finish.

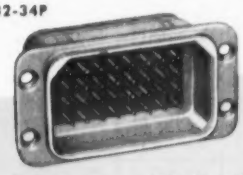
Insert arrangements — 5 plus coaxials in 9, 15, 25, 37 and 50 contacts.

Insulation material — Zytel 101 or DIALL.

Polarization — Keystone cornered shell.

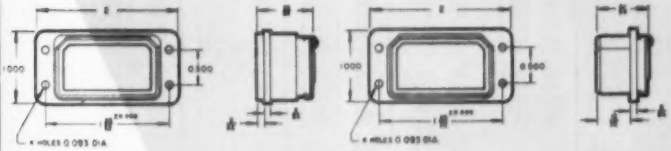
Operating temperature —67° to +310°F.

DPA 32-34P



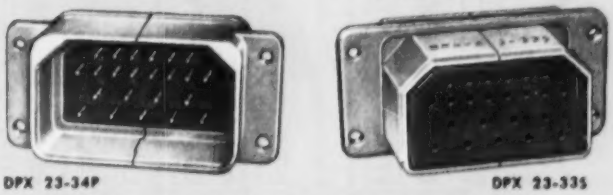
DPA 32-33S

DPA CONNECTORS:
Shell with retaining plate. Pin and Socket Inserts.

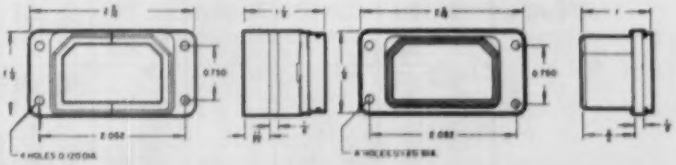


Send for illustrated Catalog No. 157 with details of "D" Sub-Miniature, "DPA" and "DPX" Series.

DPX CONNECTORS:
Split shell. Pin and Socket Inserts.



DPX 23-34P DPX 23-33S



For your connector requirements—you can depend on CINCH.

Centrally located plants at Chicago, Illinois; Shelbyville, Indiana; LaPuente, California; St. Louis, Missouri.

☆ *Manufactured by Agreement with Cannon Electric Company*

CINCH MANUFACTURING CORPORATION
1026 South Homan Ave., Chicago 24, Illinois
Subsidiary of United-Carr Fastener Corporation, Cambridge, Mass.

TEMPERATURE Conversion Chart

°C	°F	°C	°F	°C	°F	°C	°F	°C	°F	°C	°F	°C	°F	°C	°F	°C	°F	°C	°F
−200	−328.0	−100	−148.0	0	32.0	0	32.0	100	212.0	200	392.0	300	572.0	400	752.0	500	932.0	600	1,112.0	700	1,292.0
−201	−329.8	−101	−149.8	−1	30.2	1	33.8	101	213.8	201	393.8	301	573.8	401	753.8	501	933.8	601	1,113.8	701	1,293.8
−202	−331.6	−102	−151.6	−2	28.4	2	35.6	102	215.6	202	395.6	302	575.6	402	755.6	502	935.6	602	1,115.6	702	1,295.6
−203	−333.4	−103	−153.4	−3	26.6	3	37.4	103	217.4	203	397.4	303	577.4	403	757.4	503	937.4	603	1,117.4	703	1,297.4
−204	−335.2	−104	−155.2	−4	24.8	4	39.2	104	219.2	204	399.2	304	579.2	404	759.2	504	939.2	604	1,119.2	704	1,299.2
−205	−337.0	−105	−157.0	−5	23.0	5	41.0	105	221.0	205	401.0	305	581.0	405	761.0	505	941.0	605	1,121.0	705	1,301.0
−206	−338.8	−106	−158.8	−6	21.2	6	42.8	106	222.8	206	402.8	306	582.8	406	762.8	506	942.8	606	1,122.8	706	1,302.8
−207	−340.6	−107	−160.6	−7	19.4	7	44.6	107	224.6	207	404.6	307	584.6	407	764.6	507	944.6	607	1,124.6	707	1,304.6
−208	−342.4	−108	−162.4	−8	17.6	8	46.4	108	226.4	208	406.4	308	586.4	408	766.4	508	946.4	608	1,126.4	708	1,306.4
−209	−344.2	−109	−164.2	−9	15.8	9	48.2	109	228.2	209	408.2	309	588.2	409	768.2	509	948.2	609	1,128.2	709	1,308.2
−210	−346.0	−110	−166.0	−10	14.0	10	50.0	110	230.0	210	410.0	310	590.0	410	770.0	510	950.0	610	1,130.0	710	1,310.0
−211	−347.8	−111	−167.8	−11	12.2	11	51.8	111	231.8	211	411.8	311	591.8	411	771.8	511	951.8	611	1,131.8	711	1,311.8
−212	−349.6	−112	−169.6	−12	10.4	12	53.6	112	233.6	212	413.6	312	593.6	412	773.6	512	953.6	612	1,133.6	712	1,313.6
−213	−351.4	−113	−171.4	−13	8.6	13	55.4	113	235.4	213	415.4	313	595.4	413	775.4	513	955.4	613	1,135.4	713	1,315.4
−214	−353.2	−114	−173.2	−14	6.8	14	57.2	114	237.2	214	417.2	314	597.2	414	777.2	514	957.2	614	1,137.2	714	1,317.2
−215	−355.0	−115	−175.0	−15	5.0	15	59.0	115	239.0	215	419.0	315	599.0	415	779.0	515	959.0	615	1,139.0	715	1,319.0
−216	−356.8	−116	−176.8	−16	3.2	16	60.8	116	240.8	216	420.8	316	600.8	416	780.8	516	960.8	616	1,140.8	716	1,320.8
−217	−358.6	−117	−178.6	−17	1.4	17	62.6	117	242.6	217	422.6	317	602.6	417	782.6	517	962.6	617	1,142.6	717	1,322.6
−218	−360.4	−118	−180.4	−18	−0.4	18	64.4	118	244.4	218	424.4	318	604.4	418	784.4	518	964.4	618	1,144.4	718	1,324.4
−219	−362.2	−119	−182.2	−19	−2.2	19	66.2	119	246.2	219	426.2	319	606.2	419	786.2	519	966.2	619	1,146.2	719	1,326.2
−220	−364.0	−120	−184.0	−20	−4.0	20	68.0	120	248.0	220	428.0	320	608.0	420	788.0	520	968.0	620	1,148.0	720	1,328.0
−221	−365.8	−121	−185.8	−21	−5.8	21	69.8	121	249.8	221	429.8	321	609.8	421	789.8	521	969.8	621	1,149.8	721	1,329.8
−222	−367.6	−122	−187.6	−22	−7.6	22	71.6	122	251.6	222	431.6	322	611.6	422	791.6	522	971.6	622	1,151.6	722	1,331.6
−223	−369.4	−123	−189.4	−23	−9.4	23	73.4	123	253.4	223	433.4	323	613.4	423	793.4	523	973.4	623	1,153.4	723	1,333.4
−224	−371.2	−124	−191.2	−24	−11.2	24	75.2	124	255.2	224	435.2	324	615.2	424	795.2	524	975.2	624	1,155.2	724	1,335.2
−225	−373.0	−125	−193.0	−25	−13.0	25	77.0	125	257.0	225	437.0	325	617.0	425	797.0	525	977.0	625	1,157.0	725	1,337.0
−226	−374.8	−126	−194.8	−26	−14.8	26	78.8	126	258.8	226	438.8	326	618.8	426	798.8	526	978.8	626	1,158.8	726	1,338.8
−227	−376.6	−127	−196.6	−27	−16.6	27	80.6	127	260.6	227	440.6	327	620.6	427	800.5	527	980.6	627	1,160.6	727	1,340.6
−228	−378.4	−128	−198.4	−28	−18.4	28	82.4	128	262.4	228	442.4	328	622.4	428	802.4	528	982.4	628	1,162.4	728	1,342.4
−229	−380.2	−129	−200.2	−29	−20.2	29	84.2	129	264.2	229	444.2	329	624.2	429	804.2	529	984.2	629	1,164.2	729	1,344.2
−230	−382.0	−130	−202.0	−30	−22.0	30	86.0	130	266.0	230	446.0	330	626.0	430	806.0	530	986.0	630	1,166.0	730	1,346.0
−231	−383.8	−131	−203.8	−31	−23.8	31	87.8	131	267.8	231	447.8	331	627.8	431	807.8	531	987.8	631	1,167.8	731	1,347.8
−232	−385.6	−132	−205.6	−32	−25.6	32	89.6	132	269.6	232	449.6	332	629.6	432	809.6	532	989.6	632	1,169.6	732	1,349.6
−233	−387.4	−133	−207.4	−33	−27.4	33	91.4	133	271.4	233	451.4	333	631.4	433	811.4	533	991.4	633	1,171.4	733	1,351.4
−234	−389.2	−134	−209.2	−34	−29.2	34	93.2	134	273.2	234	453.2	334	633.2	434	813.2	534	993.2	634	1,173.2	734	1,353.2
−235	−391.0	−135	−211.0	−35	−31.0	35	95.0	135	275.0	235	455.0	335	635.0	435	815.0	535	995.0	635	1,175.0	735	1,355.0
−236	−392.8	−136	−212.8	−36	−32.8	36	96.8	136	276.8	236	456.8	336	636.8	436	816.8	536	996.8	636	1,176.8	736	1,356.8
−237	−394.6	−137	−214.6	−37	−34.6	37	98.6	137	278.6	237	458.6	337	638.6	437	818.6	537	998.6	637	1,178.6	737	1,358.6
−238	−396.4	−138	−216.4	−38	−36.4	38	100.4	138	280.4	238	460.4	338	640.4	438	820.4	538	1,000.4	638	1,180.4	738	1,360.4
−239	−398.2	−139	−218.2	−39	−38.2	39	102.2	139	282.2	239	462.2	339	642.2	439	822.2	539	1,002.2	639	1,182.2	739	1,362.2
−240	−400.0	−140	−220.0	−40	−40.0	40	104.0	140	284.0	240	464.0	340	644.0	440	824.0	540	1,004.0	640	1,184.0	740	1,364.0
−241	−401.8	−141	−221.8	−41	−41.8	41	105.8	141	285.8	241	465.8	341	645.8	441	825.8	541	1,005.8	641	1,185.8	741	1,365.8
−242	−403.6	−142	−223.6	−42	−43.6	42	107.6	142	287.6	242	467.6	342	647.6	442	827.6	542	1,007.6	642	1,187.6	742	1,367.6
−243	−405.4	−143	−225.4	−43	−45.4	43	109.4	143	289.4	243	469.4	343	649.4	443	829.4	543	1,009.4	643	1,189.4	743	1,369.4
−244	−407.2	−144	−227.2	−44	−47.2	44	111.2	144	291.2	244	471.2	344	651.2	444	831.2	544	1,011.2	644	1,191.2	744	1,371.2
−245	−409.0	−145	−229.0	−45	−49.0	45	113.0	145	293.0	245	473.0	345	653.0	445	833.0	545	1,013.0	645	1,193.0	745	1,373.0
−246	−410.8	−146	−230.8	−46	−50.8	46	114.8	146	294.8	246	474.8	346	654.8	446	834.8	546	1,014.8	646	1,194.8	746	1,374.8
−247	−412.6	−147	−232.6	−47	−52.6	47	116.6	147	296.6	247	476.6	347	656.6	447	836.6	547	1,016.6	647	1,196.6	747	1,376.6
−248	−414.4	−148	−234.4	−48	−54.4	48	118.4	148	298.4	248	478.4	348	658.4	448	838.4	548	1,018.4	648	1,198.4	748	1,378.4
−249	−416.2	−149	−236.2	−49	−56.2	49	120.2	149	300.2	249	480.2	349	660.2	449	840.2	549	1,020.2	649	1,200.2	749	1,380.2
−250	−418.0	−150	−238.0	−50	−58.0	50	122.0	150	302.0	250	482.0	350	662.0	450	842.0	550	1,022.0	650	1,202.0	750	1,382.0
−251	−419.8	−151	−239.8	−51	−59.8	51	123.8	151	303.8	251	483.8	351	663.8	451	843.8	551	1,023.8	651	1,203.8	751	1,383.8
−252	−421.6	−152	−241.6	−52	−61.6	52	125.6	152	305.6	252	485.6	352	665.6	452	845.6	552	1,025.6	652	1,205.6	752	1,385.6
−253	−423.4	−153	−243.4	−53	−63.4	53	127.4	153	307.4	253	487.4	353	667.4	453	847.4	553	1,027.4	653	1,207.4	753	1,387.4
−254	−425.2	−154	−245.2	−54	−65.2	54	129.2	154	309.2	254	489.2	354	669.2	454	849.2	554	1,029.2	654	1,209.2	754	1,389.2
−255	−427.0	−155	−247.0	−55	−67.0	55	131.0	155	311.0	255	491.0	355	671.0	455	851.0	555	1,031.0	655	1,211.0	755	1,391.0
−256	−428.8	−156	−248.8	−56	−68.8	56	132.8	156	312.8	256	492.8	356	672.8	456	852.8	556	1,032.8	656	1,212.8	756	1,392.8
−257	−430.6	−157	−250.6	−57	−70.6	57	134.6	157	314.6	257	494.6	357	674.6	457	854.6	557	1,034.6	657	1,214.6	757	1,394.6
−258	−432.4	−158	−252.4	−58	−72.4	58	136.4	158	316.4	258	496.4	358	676.4	458	856.4	558	1,036.4	658	1,216.4	758	1,396.4
−259	−434.2	−159	−254.2	−59	−74.2	59	138.2	159	318.2	259	498.2	359	678.2	459	858.2	559	1,038.2	659	1,218.2	759	1,398.2
−260	−436.0	−160	−256.0	−60	−76.0	60	140.0	160	320.0	260	500.0	360	680.0	460	860.0	560	1,040.0	660	1,220.0	760	1,400.0
−261	−437.8	−161	−257.8	−61	−77.8	61	141.8	161	321.8	261	501.8	361	681.8	461	861.8	561	1,041.8	661	1,221.8	761	1,401.8
−262	−439.6	−162	−259.6	−62	−79.6	62	143.6	162	323.6	262	503.6	362	683.6	462	863.6	562	1,043.6	662	1,223.6	762	1,403.6
−263	−441.4	−163	−261.4	−63	−81.4	63	145.4	163	325.4	263	505.4	363	685.4	463	865.4	563	1,045.4	663	1,225.4	763	1,405.4
−264	−443.2	−164	−263.2	−64	−83.2	64	147.2	164	327.2	264	507.2	364	687.2	464	867.2	564	1,047.2	664	1,227.2	764	1,407.2
−265	−445.0	−165	−265.0	−65	−85.0	65	149.0	165	329.0	265	509.0	365	689.0	465	869.0	565	1,049.0	665	1,229.0	765	1,409.0
−266	−446.8	−166	−266.8	−66	−86.8	66	150.8	166	330.8	266	510.8	366	690.8	466	870.8	566	1,050.8	666	1,230.8	766	1,410.8
−267	−448.6	−167	−268.6	−67	−88.6	67	152.6	167	332.6	267	512.6	367	692.6	467	872.6	567	1,052.6	667	1,232.6	767	1,412.6
−268	−450.4	−168	−270.4	−68	−90.4	68	154.4	168	334.4	268	514.4	368	694.4	468	874.4	568	1,054.4	668	1,234.4	768	1,414.4
−269	−452.2	−169	−272.2	−69	−92.2	69	156.2	169	336.2	269	516.2	369	696.2	469	876.2	569	1,056.2	669	1,236.2	769	1,416.2
−270	−454.0	−170	−274.0	−70	−94.0	70	158.0	170	338.0	270	518.0	370	698.0	470	878.0	570	1,058.0	670	1,238.0	770	1,418.0
−271	−455.8	−171	−275.8	−71	−95.8	71	159.8	171	339.8	271	519.8	371	699.8	471	879.8	571	1,059.8	671	1,239.8	771	1,419.8
−272	−457.6	−172	−277.6	−72	−97.6	72	161.6	172	341.6	272	521.6	372	701.6	472	881.6	572	1,061.6	672	1,241.6	772	1,421.6
−273	−459.4	−173	−279.4	−73	−99.4	73	163.4	173	343.4	273	523.4	373	703.4	473	883.4	573	1,063.4	673	1,243.4	773	1,423.4
−273.2	**−459.7**	−174	−281.2	−74	−101.2	74	165.2	174	345.2	274	525.2	374	705.2	474	885.2	574	1,065.2	674	1,245.2	774	1,425.2
Absolute Zero		−175	−283.0	−75	−103.0	75	167.0	175	347.0	275	527.0	375	707.0	475	887.0	575	1,067.0	675	1,247.0	775	1,427.0
		−176	−284.8	−76	−104.8	76	168.8	176	348.8	276	528.8	376	708.8	476	888.8	576	1,068.8	676	1,248.8	776	1,428.8
		−177	−286.6	−77	−106.6	77	170.6	177	350.6	277	530.6	377	710.6	477	890.6	577	1,070.6	677	1,250.6	777	1,430.6
		−178	−288.4	−78	−108.4	78	172.4	178	352.4	278	532.4	378	712.4	478	892.4	578	1,072.4	678	1,252.4	778	1,432.4
		−179	−290.2	−79	−110.2	79	174.2	179	354.2	279	534.2	379	714.2	479	894.2	579	1,074.2	679	1,254.2	779	1,434.2
		−180	−292.0	−80	−112.0	80	176.0	180	356.0	280	536.0	380	716.0	480	896.0	580	1,076.0	680	1,256.0	780	1,436.0
Formulas:		−181	−293.8	−81	−113.8	81	177.8	181	357.8	281	537.8	381	717.8	481	897.8	581	1,077.8	681	1,257.8	781	1,437.8
		−182	−295.6	−82	−115.6	82	179.6	182	359.6	282	539.6	382	719.6	482	899.6	582	1,079.6	682	1,259.6	782	1,439.6
		−183	−297.4	−83	−117.4	83	181.4	183	361.4	283	541.4	383	721.4	483	901.4	583	1,081.4	683	1,261.4	783	1,441.4
$C = \frac{5}{9}(F - 32)$		−184	−299.2	−84	−119.2	84	183.2	184	363.2	284	543.2	384	723.2	484	903.2	584	1,083.2	684	1,263.2	784	1,443.2
		−185	−301.0	−85	−121.0	85	185.0	185	365.0	285	545.0	385	725.0	485	905.0	585	1,085.0	685	1,265.0	785	1,445.0
$F = \frac{9}{5}C + 32$		−186	−302.8	−86	−122.8	86	186.8	186	366.8	286	546.8	386	726.8	486	906.8	586	1,086.8	686	1,266.8	786	1,446.8
		−187	−304.6	−87	−124.6	87	188.6	187	368.6	287	548.6	387	728.6	487	908.6	587	1,088.6	687	1,268.6	787	1,448.6
		−188	−306.4	−88	−126.4	88	190.4	188	370.4	288	550.4	388	730.4	488	910.4	588	1,090.4	688	1,270.4	788	1,450.4
		−189	−308.2	−89	−128.2	89	192.2	189	372.2	289	552.2	389	732.2	489	912.2	589	1,092.2	689	1,272.2	789	1,452.2
		−190	−310.0	−90	−130.0	90	194.0	190	374.0	290	554.0	390	734.0	490	914.0	590	1,094.0	690	1,274.0	790	1,454.0
		−191	−311.8	−91	−131.8	91	195.8	191	375.8	291	555.8	391	735.8	491	915.8	591	1,095.8	691	1,275.8	791	1,455.8
		−192	−313.6	−92	−133.6	92	197.6	192	377.6	292	557.6	392	737.6	492	917.6	592	1,097.6	692	1,277.6	792	1,457.6
		−193	−315.4	−93	−135.4	93	199.4	193	379.4	293	559.4	393	739.4	493	919.4	593	1,099.4	693	1,279.4	793	1,459.4
		−194	−317.2	−94	−137.2	94	201.2	194	381.2	294	561.2	394	741.2	494	921.2	594	1,101.2	694	1,281.2	794	1,461.2
		−195	−319.0	−95	−139.0	95	203.0	195	383.0	295	563.0	395	743.0	495	923.0	595	1,103.0	695	1,283.0	795	1,463.0
		−196	−320.8	−96	−140.8	96	204.8	196	384.8	296	564.8	396	744.8	496	924.8	596	1,104.8	696	1,284.8	796	1,464.8
		−197	−322.6	−97	−142.6	97	206.6	197	386.6	297	566.6	397	746.6	497	926.6	597	1,106.6	697	1,286.6	797	1,466.6
		−198	−324.4	−98	−144.4	98	208.4	198	388.4	298	568.4	398	748.4	498	928.4	598	1,108.4	698	1,288.4	798	1,468.4
		−199	−326.2	−99	−146.2	99	210.2	199	390.2	299	570.2	399	750.2	499	930.2	599	1,110.2	699	1,290.2	799	1,470.2

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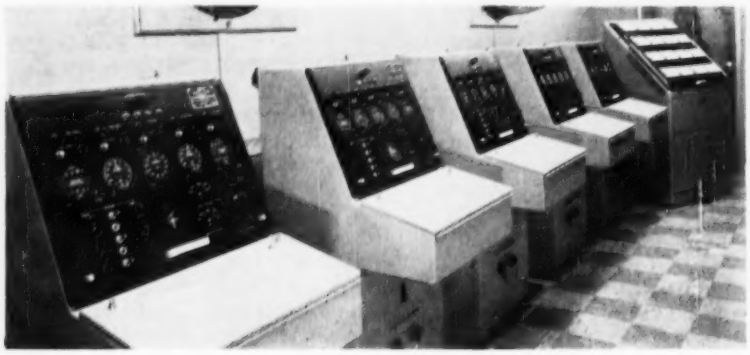
Electrons At Work

Edited by ALEXANDER A. McKENZIE

Air-Ground Data Link To Cut Stacking



Five monitor consoles and address board (right) used for assigning identities to aircraft at Tacan data-link ground station. Each console displays complete information for a selected aircraft as well as ordered condition

SOLUTION of the conflict between VOR-DME and Tacan having been resolved in the adoption of combined Vortac, it is now possible to implement the military system (Tacan) with additional communication of intelligence that may one day be of great use to commercial flying.

The Tacan data link equipment developed for the Navy by Federal Telecommunication Laboratories provides service for 120 aircraft on any of the 126 Tacan channels in less than 3 seconds. Individual orders of bearing, distance, heading, altitude and speed can be transmitted to each aircraft. Any one of 31 standard messages can likewise be sent from computers or manual control positions.

Each of the 120 aircraft automatically encodes a report of its bearing, speed, altitude and other pertinent data and this is sent to the ground where it is used by computers or for visual displays. In addition, 31 standard messages can be transmitted by pushbutton control from air to ground.

► **Link Capacity**—The data link handles 45 ground-air and 45 air-ground, or a total of 90 messages a second. Since each Vortac installation has a capacity of 120 aircraft simultaneously, each 2⅔ seconds every aircraft can receive a private-line order and transmit an automatic report. These limitations are arbitrary and not inherent in the system.

The basis of the Tacan system has been described (ELECTRONICS, p 174, Oct. 1955). In summary, a complex rotating pattern is transmitted from the ground antenna on a 1-mc band over channels in the region of 962 through 1,213 mc. The pattern can be described as a 9-lobed cog wheel combined with a cardioid.

In addition to an omidirectional north pulse transmitted each time the cardioid component rotates through north, a different, characteristic reference pulse is transmitted each time a cog of the 9-toothed wheel passes through north.

Physical rotation of the Tacan antenna occurs at a 15-rps rate. To the airborne observer there is an appearance of a fundamental component at 15 cps and a 9th harmonic component at 135 cps. In each antenna revolution, one north pulse is generated and 8 reference pulses. Time between successive reference pulses is 1/135th second.

► **Rotational Modulation**—The rotating directional pattern of the ground beacon antenna modulates signals presented to it by the transmitter. The fine grain structure of the transmitted signal is

Radio Printer For Air Commands

Airborne teletypewriter developed for Air Research and Development Command by Kleinschmidt Laboratories, Inc. is compared with standard machine (upper left). Printer section of the new machine is shown at left with control box (center) and keyboard (right). Terminal unit, which is the heart of the new teleprinter is at upper right. The new machine uses a type wheel and hammer on a pressure-sensitive paper

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OUTPUT CURRENT DC: 0-15 amperes continuous duty.

REGULATION: In the range 2-36 volts the output voltage variation is less than 0.5% for line fluctuation from 105-125 volts, and less than 0.5% or 25 millivolts, whichever is greater, for load variations from minimum to maximum current.

RIPPLE VOLTAGE: Less than 0.5% or 25 millivolts RMS, whichever is greater.

FUSE PROTECTION: Input fuses on front panel.

OVERLOAD PROTECTION: An automatic current limiting device allows direct shorting of the output terminals without damage to the supply.

POWER REQUIREMENTS: 105-125 volts, 57-63 cycles.

OUTPUT TERMINATIONS: DC terminals are clearly marked on the front panel. Either positive or negative terminal of the supply may be grounded. DC terminals are isolated from the chassis. A binding post is available for connecting to the chassis. All terminals are also brought out at the rear of the chassis. Two terminals are mounted at the rear of the chassis to provide for picking up the error signal directly at the load. This connection compensates for the voltage drop in the wires connecting the power supply to the load.

METERS: Ammeter: 0-15 amperes, 4" rectangular
Voltmeter: 0-15 volts, 4" rectangular

CONTROLS: Power on-off switch, DC on-off switch, remote error signal on-off switch, coarse and fine voltage controls.

PHYSICAL SPECIFICATIONS: Rack panel construction. Panel height 12¼", width 19", depth 17". Color Kepco standard gray hammertone. This unit is designed for relay rack mounting or bench use. Carry handles are provided.

OPERATIONAL CHARACTERISTICS: This regulated unit consists of a ferro-resonant line regulator followed by a magnetic amplifier regulator. The ferro-resonant line regulator furnishes well regulated transient free AC power. The high gain magnetic amplifier is used to regulate the DC output voltage to compensate for voltage changes in the power unit for varying load currents. The response time for pulse loads is less than 0.2 seconds.

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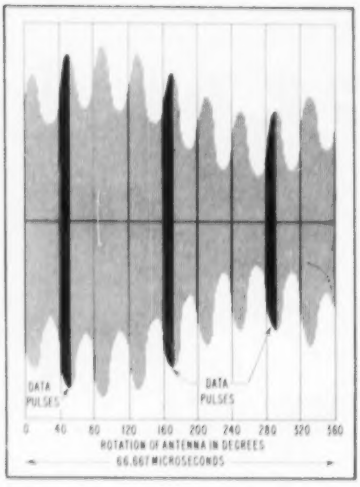


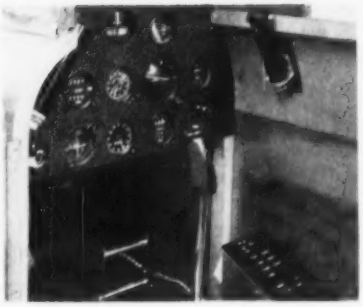
FIG. 1—Data-link beacon transmission

composed of pulses, averaging 5,400 transmitted each second. Exact pulse positions carry distance and data link information.

Aircraft transmit a pair of interrogating pulses having 12-μsec spacing that are received at the ground beacon. Automatic reply from the beacon provides an elapsed time to indicate distance of the aircraft from the beacon. Since the airborne receiver is effectively gated for reception of the desired signal only, about 50 percent of the pulses received do not affect Tacan operation.

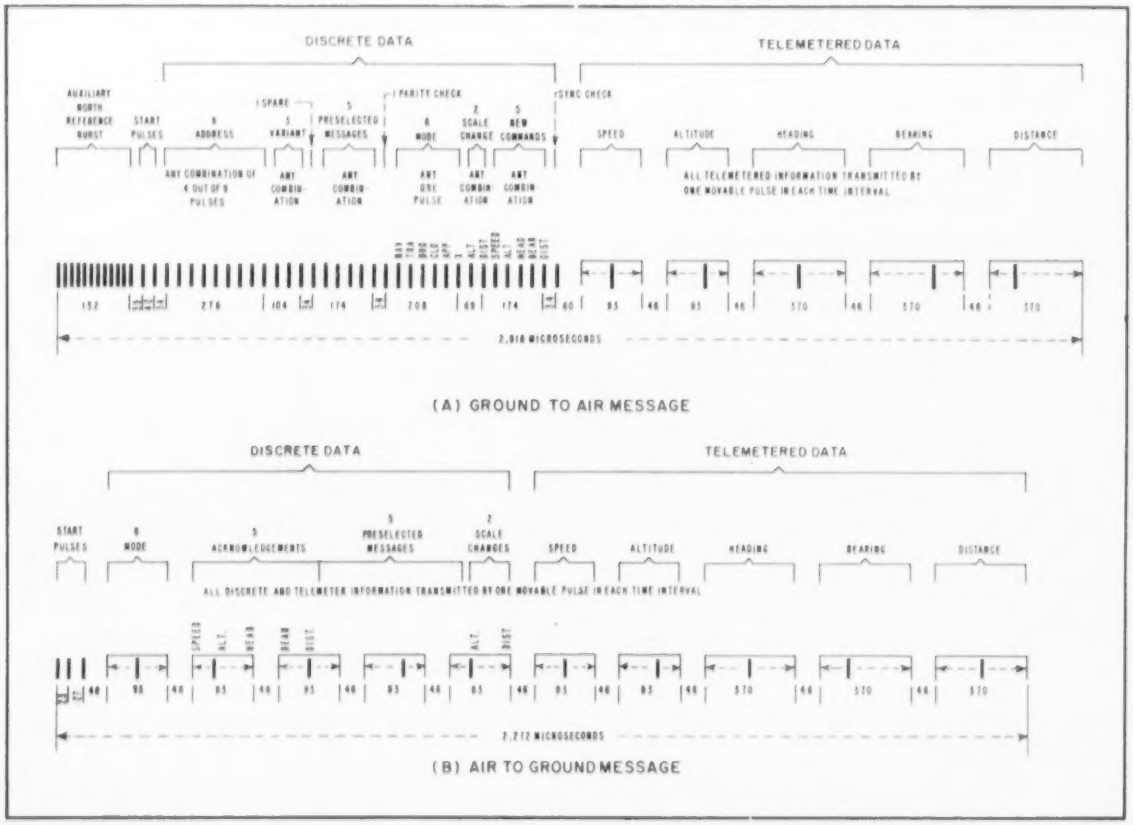
The basic Tacan synchronizing signal occurs at a 135-cps rate and the same signal is used for the data link. Forty-five times a second the surface equipment stops transmission of standard pulses and inserts a burst of pulses with special configuration that conveys the entire ground-air transmission to a single craft. Such a pulse burst is about 3 milliseconds long. Immediately following, the desired aircraft transmits a reply comprising discrete data and telemetered reports of its status.

Rounded pulse pairs are sent in an appropriate form of modulation. Instrument dial readings employ analog codes of pulse position modulation. Digital-type data, such as predetermined messages, employ digital codes.



Flight trainer installation of data link. Canned messages are displayed on dial right center. They are sent from box lower right

► **Message Structure**—The method of sending pulse pairs is shown below where such pair is represented, for simplicity, by a single line. Digital data indicating aircraft identity, predetermined messages, mode of operation and procedural information is sent first,



Tacan data-link code structure for ground-air and air-ground messages uses digital and analog codes

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The straight inside story on the new series 5000 is available in data file 521.

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followed by five pulse-position analog-type telemetered control orders.

After receipt of complete order sequence from the ground, the aircraft then transmits air-surface information as shown.

Figure 1 shows radio output received due south of a ground beacon. The r-f envelope indicates relative depth of modulation for 15 and 135-cps frequencies and the heavy lines show reference-pulse bursts at 40-deg points. These two modulations are for bearing indications. By limiting, only the unmodulated central section is extracted for distance measurement. There are 3,600 pairs of pulses transmitted each second on the average, including bursts of more closely spaced reference pulses. The data link is not yet available for civil aircraft.

Transistor Beta Tester

By G. Franklin Montgomery
Electronic Scientist
National Bureau of Standards
Washington, D. C.

The instrument described in this article is designed to measure the common-emitter short-circuit current gain of *npn* or *pnp* junction transistors at low audio frequency.

In operation, the transistor is plugged into the instrument and a dial is adjusted to the point where audio oscillation just begins, as evidenced by a loudspeaker tone. The current gain β is then read directly from the dial. Properly calibrated, the instrument will measure β with an accuracy of a few percent. Inexpensive parts are used in its construction.

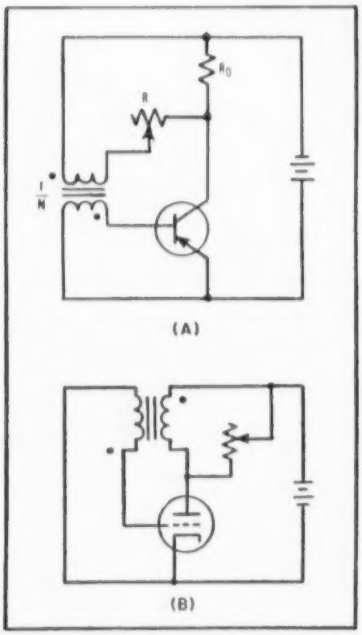
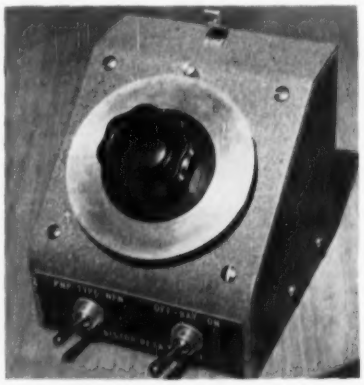


FIG. 1—Simplified form of beta tester (A) and tube analog (B)

A simplified diagram of the tester is shown in Fig. 1A. It is first assumed that R_o is small compared with the transistor output impedance and that R is large compared with $1/N^2$ times the transistor input impedance, where N is



Transistor beta tester with calibrated and engraved dial

the turns ratio of the transformer. In practice, these assumptions are easily realized for most transistors. Then, for the value of R at which oscillation just begins, the base current is

$$I_b = -\frac{I_c R_o}{N(R_o + R)} \qquad (1)$$

where I_c is the collector current and therefore

$$\beta = -I_c/I_b = N(1 + R/R_o) \qquad (2)$$

Variable resistor R can thus be calibrated to read β directly and in the range where $R/R_o >> 1$ the calibration will be linear if a linear potentiometer is used for R. The circuit of Fig. 1A will be recognized as similar to that of Fig. 1B, an arrangement that was used by

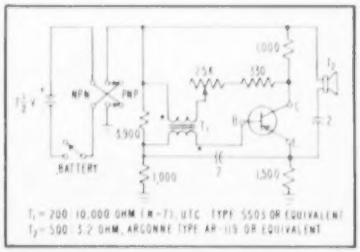


FIG. 2—Complete circuit of the transistor beta tester

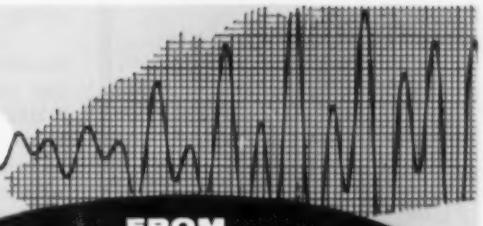
L. R. Philpott at NRL in 1940 for measuring vacuum-tube transconductance.

▶**Controls**—To reduce the number of controls to a minimum, the circuit is arranged so the transistor will adjust itself to a specified d-c operating point. The complete circuit diagram is shown in Fig. 2, wherein the resistances have been chosen to fix the operating point at about 5 v collector potential and 1 ma collector current. For any transistor whose β is within the measuring range of the instrument, these d-c values will be approximated closely.

The frequency at which oscillation begins will depend upon the characteristics of the transformer and the phase shift of β. The current ratio of the usual transformer has a broad maximum centered at 1 or 2 kc and if the phase shift of the transistor is sufficiently small, oscillation will begin at a frequency near this maximum.

For transistors having a larger phase shift, the oscillation frequency will be reduced. The amplitude of β required to produce oscillation for a given dial setting, however, is not a particularly sensitive function of frequency, so

TECHNIQUES and DEVELOPMENTS in oscillographic recording

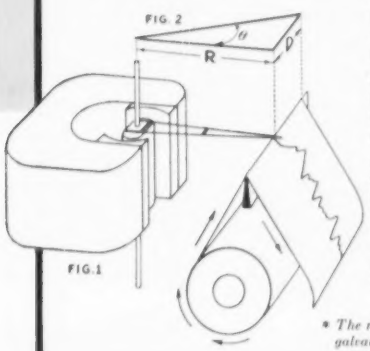


FROM SANBORN

RECORDING METHOD USED IN SANBORN DIRECT WRITERS, AND A REVIEW OF THEORETICAL AND ACTUAL ERROR FACTORS

Figure 1 shows the basic scheme by which Sanborn oscillographic recording galvanometers produce graphic records of electrical signal values. If the rapid deflection action of the heated ribbon tip stylus is visualized when current flows in the coil, it can be seen that a straight line at right angles to the chart length is recorded on the chart, at the point where the chart is drawn over a knife edge. The trace, therefore, is a true rectangular co-ordinate graph.

Since this is essentially a process of expressing coil (or stylus) deflection *angles* in terms of *distances* on a chart, the trigonometry of the situation (Fig. 2) must be examined to ascertain the accuracy of the method. Initially, and when θ is small, the tangent and the angle are almost equal numerically. The expression $D = R \tan \theta$ can, therefore, be rewritten $D = R\theta$ (approx.). To the extent this latter expression is true, deflection distances (rather than deflection angles) are an accurate measure of signal values. But to determine the extent of error resulting from using this approximation, the following data have been calculated*, using a chart width of 25 mm either side of zero ("D" in Fig. 2) and effective stylus length of 100 mm ("R" in Fig. 2) in the series expansion for the tangent function. Error as a function of deflection then becomes:



D mms	Radians	Theoretical Error ϵ	Corrected Error δ	Corrected Error in mms
10	.10	.0033	0	0
15	.15	.0075	.004	.06
20	.20	.0133	.010	.20
25	.25	.0209	.018	.45

When the recording system is calibrated, that calibration is often made on the basis of a one centimeter deflection from the chart center, or by means of a two centimeter deflection starting one centimeter below chart center and finishing one centimeter above chart center. In either case the deflection at one centimeter from chart center is accepted as the standard, and, therefore, is without error. The foregoing table can therefore be corrected by subtracting .0033 from each of the error terms to show the error, δ, to be expected in actual use. The final column in the table shows this error in mms.

Since the active length of the stylus increases as θ increases, deflection D increases more rapidly than θ. All positive error terms in the series expansion bear this out, but the error terms would occur as predicted only if the galvanometer produced deflections exactly proportional to coil currents (that is, ideal spring properties in the torsion rods and uniformity of magnetic field). Pole tips in Sanborn galvanometers are proportioned so that in maximum deflections, galvanometer sensitivity *decreases* slightly, the compensation resulting in *actual* linearity better than that predicted in the table.

* *The mathematics involved here, as well as a discussion of fixed length stylii, design parameters affecting over-all galvanometer performance, etc., are contained in an article by Dr. Athur Miller "Sanborn Recording Galvanometers", published in the May 1956 Sanborn RIGHT ANGLE. Copies are available on request.*

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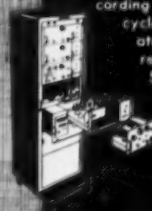

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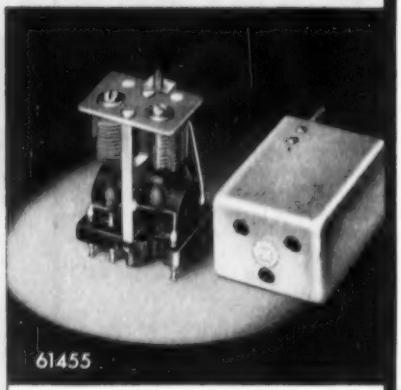

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measurements accurate to within a few percent can be expected.

▶**Measurements**—For simple comparative measurements, the dial can be roughly calibrated in accordance with Eq. 2 and the known values of N and R. For a more accurate calibration, the procedure outlined in Fig. 3 should be followed.

A voltage generator having an output of 10 to 50 volts at 1,000 cps is connected in series with a 100,000-ohm resistor between the shorted battery leads and the collector terminal of the transistor socket. A 1,000-ohm resistor is connected between the base and emitter socket terminals and the voltage developed across it is measured with a sensitive voltmeter. Then

$$\beta = \frac{E/10^5}{V/10^3} = \frac{E}{100V} \qquad (3)$$

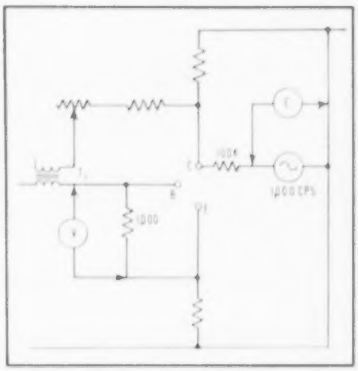

FIG. 3—Circuit shows procedure necessary for accurate calibration

and the dial may be calibrated from a series of measurements of E and V. With the circuit constants given in Fig. 2, the measurable range of β is 10 to 170.

Scatter Circuits

TOWER FOUNDATIONS are being built for the AT&T over-horizon link between Florida City, Fla. and Cuba. Construction will include a concrete block building and three towers. Work was to be completed during April.

▶**Transatlantic** — Canada will build a forward-scatter station in Newfoundland near Gander Airport at a cost of $650,000. It will constitute one link of a network recommended by ICAO to connect Gander, Narssarsuak in Greenland, Reykjavik in Iceland with Shannon and Prestwick in Ireland and Scotland, respectively. Four teleprinter channels and one voice channel will be provided.

▶**Scandinavia** — Ionospheric-scatter propagation research was started in 1954 by the Norwegian Defense Research Establishment. Rhombic and Yagi antennas were used with a transmitter power of 5 kw. Path length of the experimental, one-way circuit was about 700 miles. Since July 1956 experiments have been carried out on another one-way 50-mc circuit between Tromso in northern Norway and Kjeller in the south. This path is about 750 miles long.

▶**Obstacle Gain**—As a result of diffraction, radio signals on the far side of a sharp-edged mountain range may actually be strengthened (ELECTRONICS, p 196, May 1954). Experience in the Korean terrain indicated many cases in which radio reception was improved. Although this phenomenon is different from scatter transmission, it was observed at frequencies above 50 mc. Improvements in the order of 80 db have been experienced.

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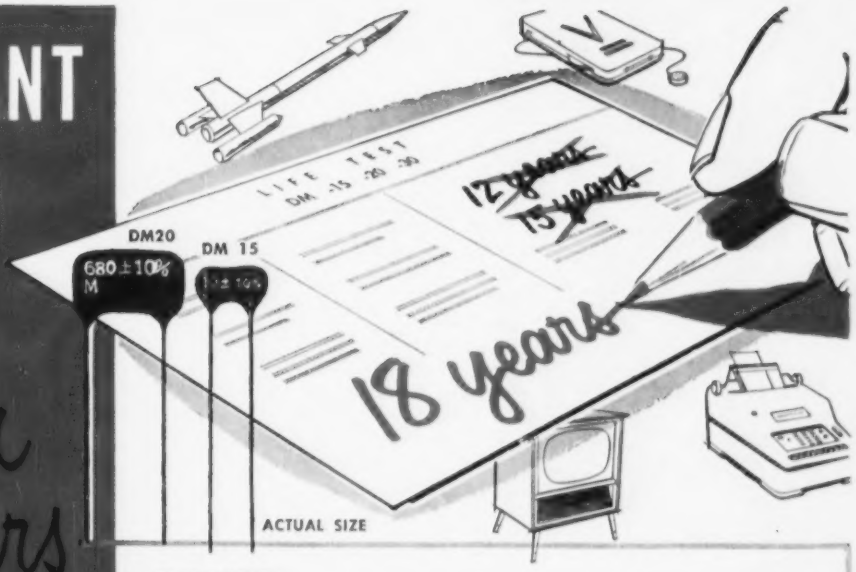

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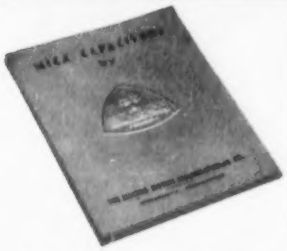

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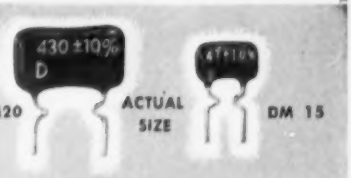

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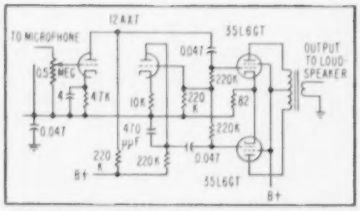
delayed about 1/20 second. The overall effect is said to produce, even in a small room, the effect of sound in a concert hall.

▶ **Delay Mechanism**—After considering the impracticability of an electrical *LC* delay line and the expense of magnetic tape storage, it was finally decided to employ an acoustic pipe about 50 feet long, with an input driver unit and sensitive microphone detector.

Because the power contained in the reverberated sound should be less than that of the main sound, a low-power amplifier shown in the circuit diagram is used. Only unusual feature of the design is the floating paraphase phase inverter. This circuit, which utilizes negative feedback from plate to grid (right-hand half of 12AX7 tube) has been described in Seely's "Electron Tube Circuits".



Amplifier for the delayed channel

The so-called Xophonic unit uses a large diameter cylinder for back loading of the loudspeaker. The audio delay pipe is coiled around the cylinder.

Selector Chooses C-W Phase

By Martin D. Belfield
Diamond Ordnance Fuze Labs
Washington, D. C.

During circuit analysis or development it is often desirable to employ a c-w signal that can be triggered with a known starting-phase. This type of signal is particularly useful for evaluation of integrator networks. At present a variety of circuits is being used to accomplish this requirement.

Some of these circuits use multivibrators as electronic switches or gates. The starting point for the first cycle and the length of the wave train to follow, can be predetermined by proper circuit design. In none of this equipment, however, is the starting point made variable.

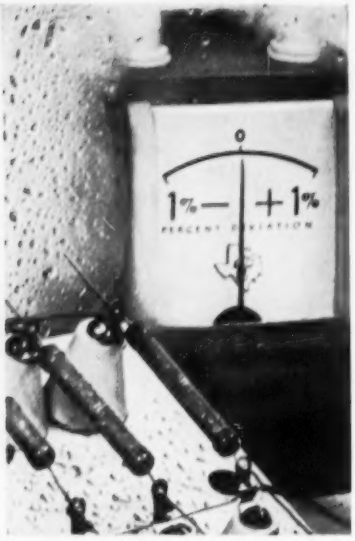
The circuit to be described offers ease of selecting a new starting-phase for the first cycle of a wave train by the simple adjustment of a calibrated dial.

The circuit shown is used in conjunction with a signal generator that provides a continuous-wave, constant-amplitude signal. With a manually operated switch, the time duration of the c-w can be controlled by the operator. The circuit provides at the output terminal a signal with a controlled starting phase for the first cycle. Considering one cycle equal to 360 electrical degrees, the operator can select for the first cycle any desired starting point from 0 to 360 deg simply by adjusting a potentiometer.

Closing switch S_1 applies the sine-wave signal to transformer T_1. The secondary windings of the transformer are connected so the signal applied to the control grid of thyratron V_1 will be 180 deg out of phase with the signal applied to

Flush-Mount Antenna

An 18 by 24-in. grid of transverse parallel wires spaced regularly over a conducting sheet comprises a flush-mount antenna developed for the Air Force by Stanford Research Institute. Used for radar, the antenna has a pencil-beam pattern with low side lobes. Mounted horizontally, it can be scanned over 40 degrees by changing frequency between 7 to 13 kmc



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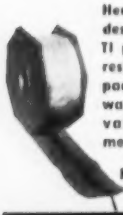

Here is a typical TI reel pack designed to speed production. TI precision deposited carbon resistors are mass produced and packaged in five sizes from ½ watt to 2 watts with resistance values from 25 ohms to 30 megohms.

For complete data, write for Bulletin DL-C 539.

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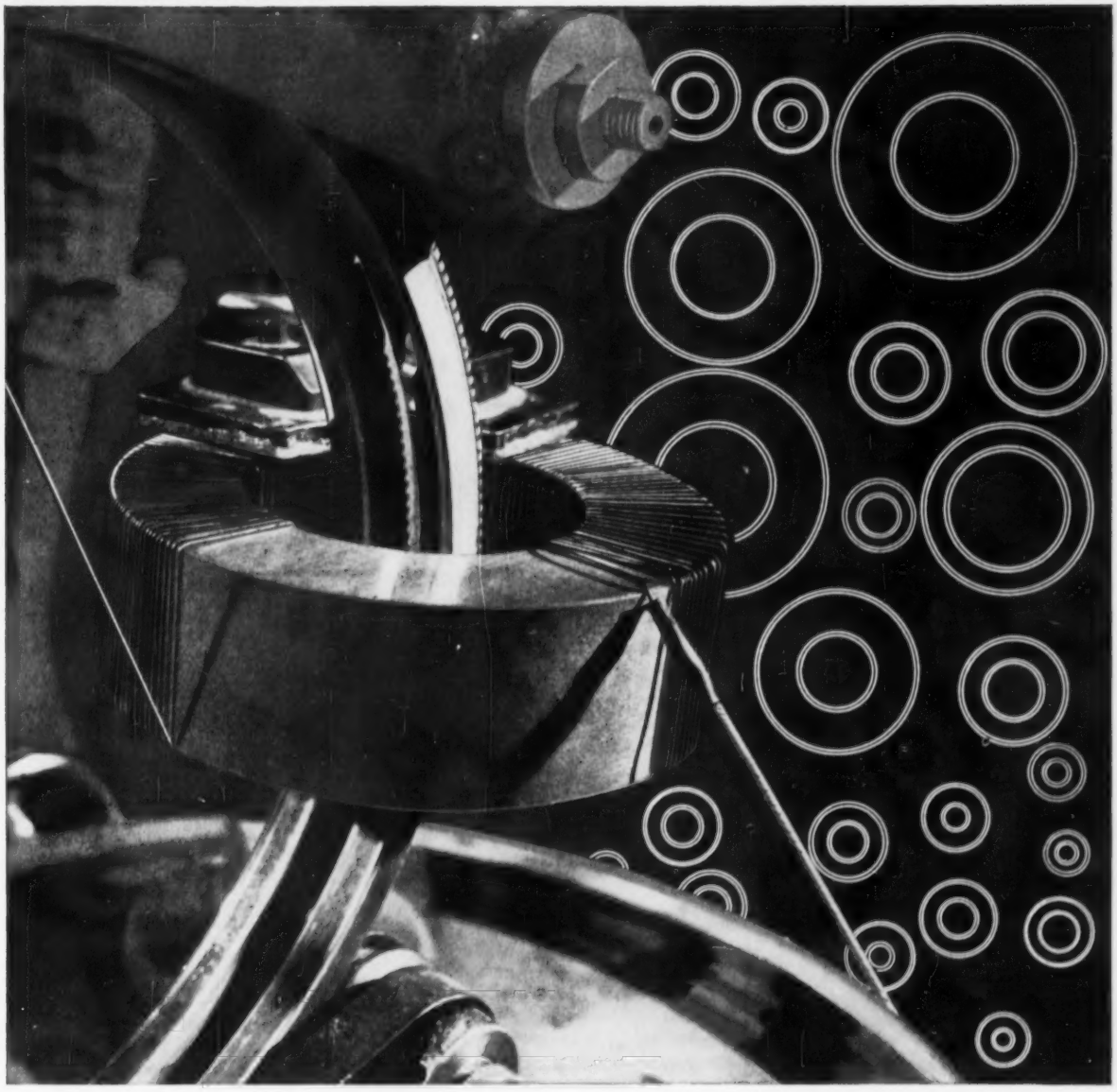

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MAGNETICS inc.

**Paper 57-206, Proposed Size Standards for Toroidal Magnetic Tape Wound Cores. Report of the Magnetic Amplifiers Material Sub-Committee, at the 1957 Winter General Meeting, A.I.E.E.*

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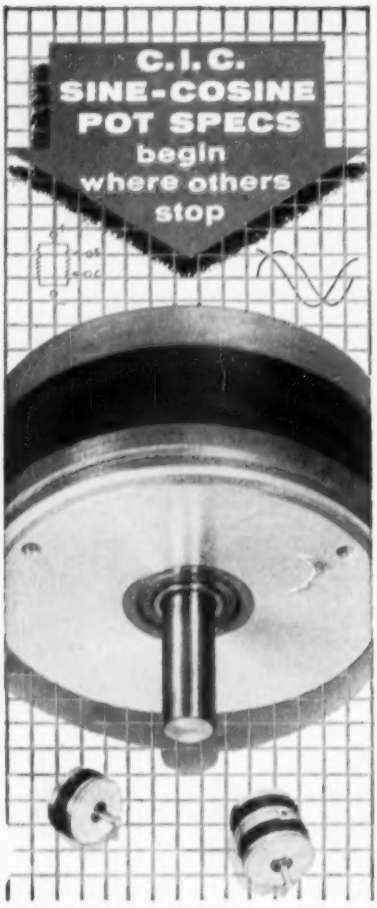

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the control grid of thyratron V_3.

Switch S_1 will be closed at some unknown point (0 to 360 electrical degrees) along the first cycle of the incoming signal. The first positive half-cycle, or part of a positive half-cycle, will fire V_1. The voltage drop across R_1, the cathode resistor of V_1, supplies the plate voltage for thyratron V_2.

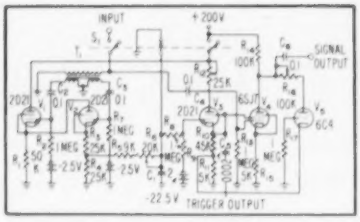
The signal applied to the control grid of V_2 is 180 deg out of phase with the signal appearing at the control grid of V_1. Tube V_2 will fire on the half-cycle immediately following the firing of V_1. With suitable negative bias voltage and signal applied to the control grid of V_2, the firing point of V_2 is accurately established.

The voltage divider and cathode resistor, $R_8 + R_9$, of V_2 supplies a positive charging voltage for the $R_5 + R_6$ and C_1 RC network. Resistor R_6 is a 10-turn potentiometer and any adjustment will increase or decrease the charging rate of C_1. As C_1 charges, the voltage rise will eventually exceed the bias applied to the grid of thyratron V_2 and fire the tube. The firing of V_2 is delayed to suit the operator.

The full voltage drop across the series cathode resistor, R_{10} and R_{11}, of V_2 is applied to the screen grid of a 6SJ7, V_4. Signal is applied to the control grid of V_4 for as long as S_1 is closed. However, no signal appears at the plate of V_4 until the screen voltage is applied. Potentiometer R_6 controls the firing of V_2 and hence the screen voltage of V_4. As a consequence, the starting position of the signal appearing at the plate of V_4 is also controlled.

If the circuit is used at one frequency only, the indicator on R_6 can be calibrated in electrical degrees delay from 0 to 360. For use over a wide frequency range it will be preferred to calibrate R_6 in milliseconds.

The 6C4, V_5, conducts only when V_4 is not conducting. The variable plate load resistor R_{13} of V_5 is adjusted to duplicate the plate current flow of V_4, when V_4 is conducting, preventing a change in the d-c voltage level that would otherwise mar the quality of the output signal. Operation of V_5 is simple. Self bias is obtained from a part of the cathode resistor R_{11} of V_2. When V_2 fires, the cathode voltage of V_5 rises to a high value making the grid negative enough to cut off the tube.



Starting-phase selector for c-w signal

When closed, S_1 applies the incoming signal and the B+ voltage to the tubes. When the switch is opened the incoming signal is cut off and the B+ removed from V_1, V_2 and V_3, extinguishing the thyratrons. A third section is added to the switch to discharge C_1, permitting the operator rapid repeat operation of the instrument without the possibility of C_1 remaining partially charged to cause errors.

Variable resistor R_{12} in series with the plate of V_2 is used to adjust the screen voltage of V_4 and the cutoff bias voltage of V_5.

Frequency response of this circuit is 20 to 2,000 cps. The frequency response can be extended if necessary by replacing the input transformer with a phase inverter and altering the values of the circuit components.

An added feature is a trigger output that can be used to trigger the trace of an oscilloscope simultaneously with the start of the c-w oscillation.

Transistor Phonograph Preamplifier

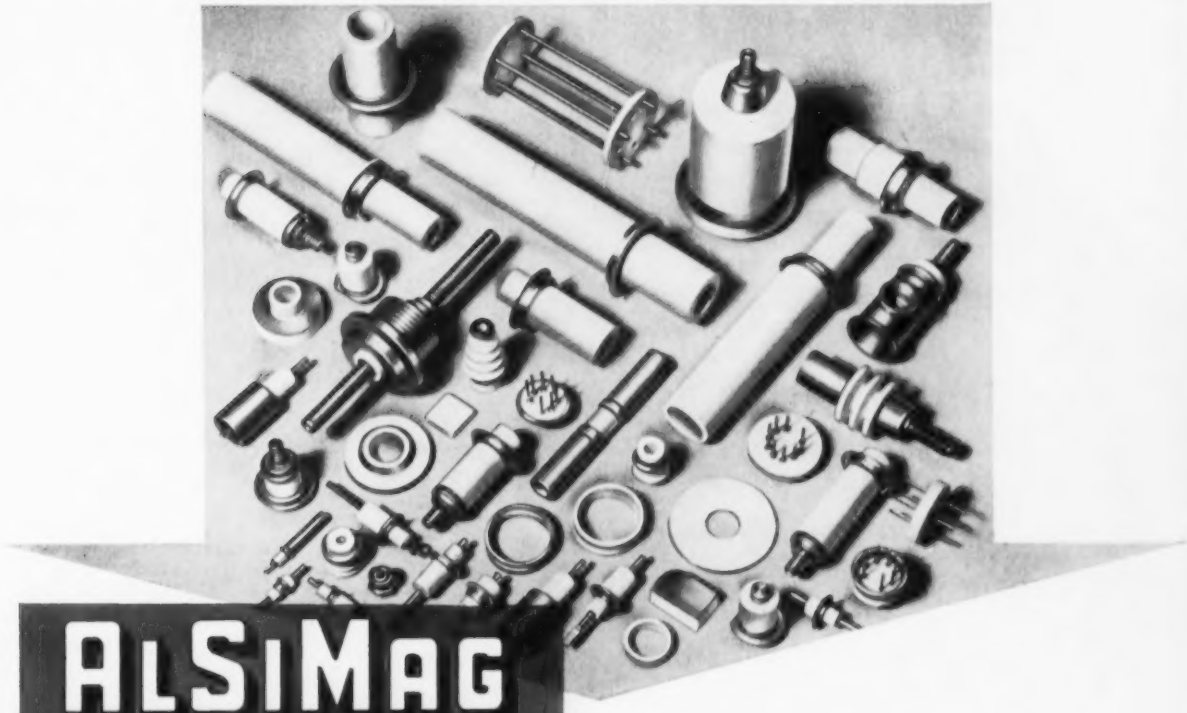
By R. Page Burr*

Burr-Brown Research Corp.
Cold Spring Harbor, N. Y.

Designed for use with low-impedance magnetic phonograph pickup cartridges of which the variable-reluctance type is a popular example, the battery-powered transistor amplifier described below is comparable to vacuum-tube am-

* Work described was performed while the author was employed by Hazeltine Corp., Little Neck, N. Y.

dependable



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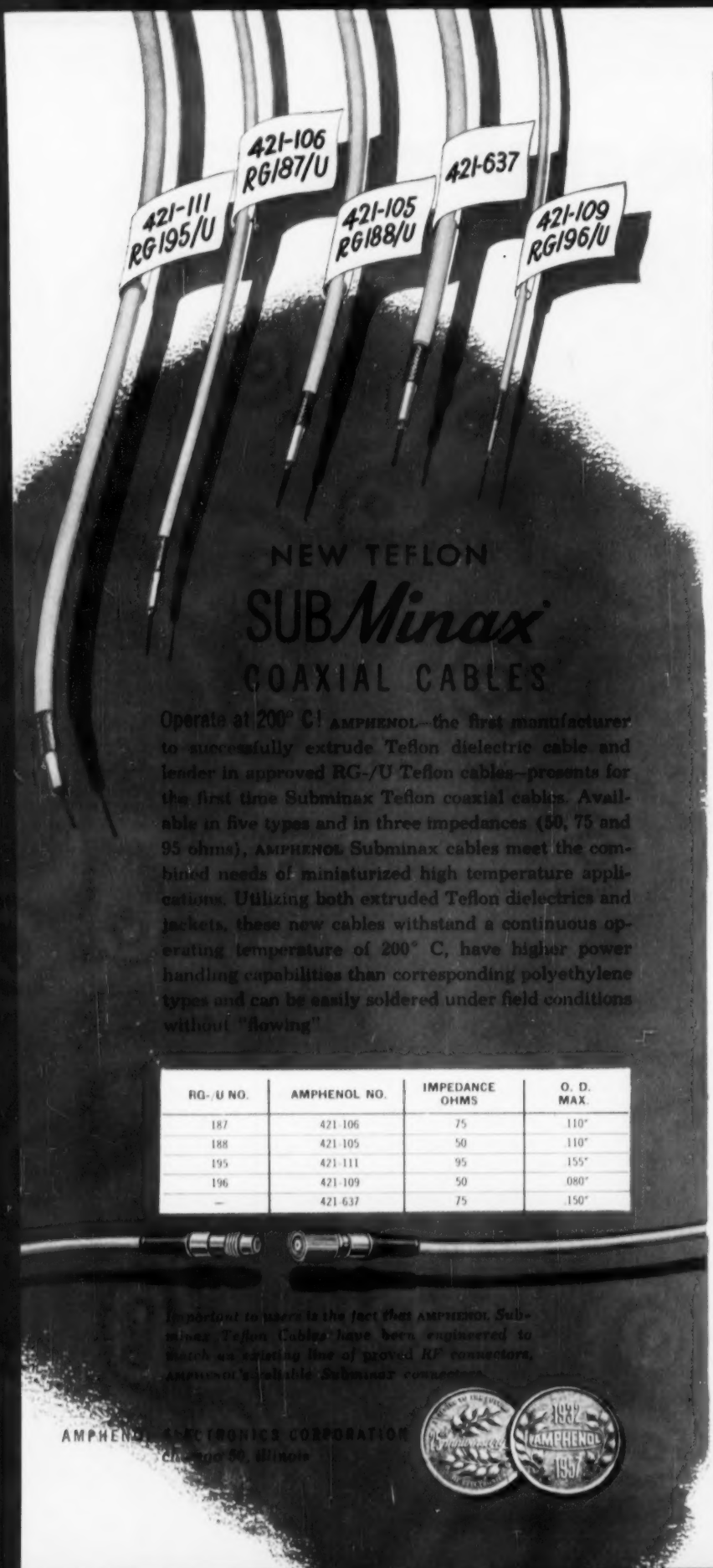
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plifiers now widely used for this purpose in high-fidelity systems.

To improve linearity of the amplifier and to stabilize the operating gain negative feedback is used. A midband voltage gain in the order of 40 db is a reasonable figure for a phonograph pickup amplifier. Stage gain of approximately 40 db is readily obtainable from junction transistors with base-to-collector current multiplication of about 40 times. Use of liberal feedback in a two-stage amplifier is therefore feasible. The two junction transistors developed a voltage gain of approximately 78 db with feedback inoperative. When the loop is closed, the gain at approximately 1 kc is close to 40 db.

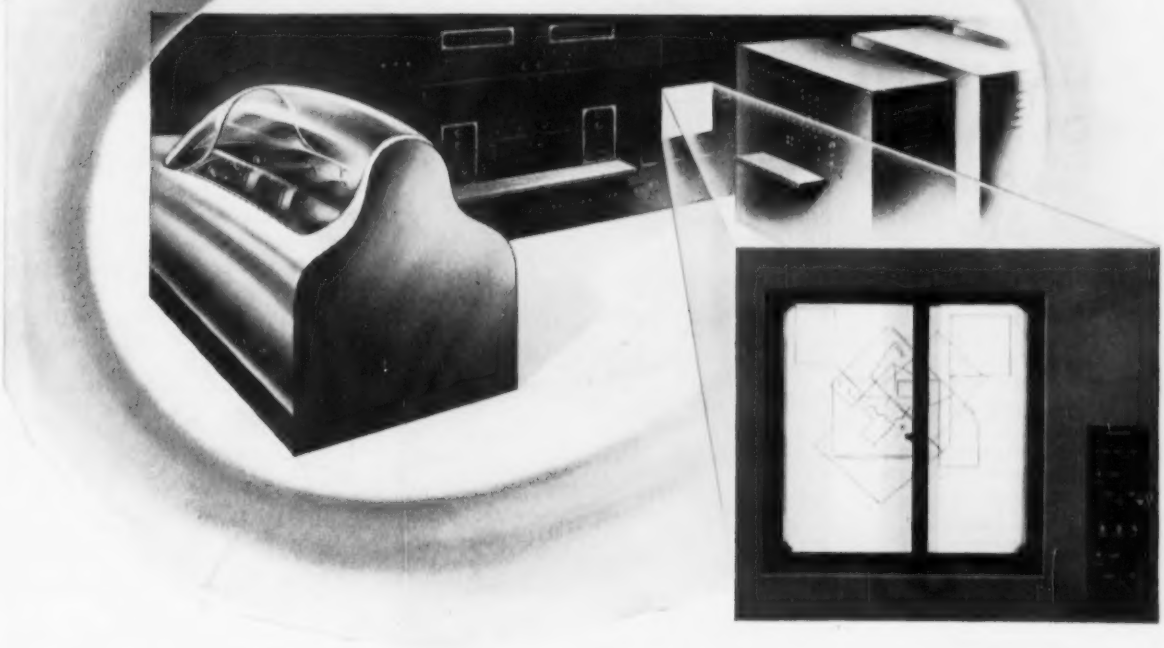
When voltage feedback is taken from the output anode circuit of an electron tube and is returned to the cathode of the input tube, the advantages of simultaneously raising the input impedance and lowering the output or source impedance of the system result. Low output impendance is desirable because preamplifiers of this type are often used to feed long shielded cables having high total shunt capacitance.

▶ **Amplification**—The gain needed for a phonograph preamplifier may be calculated using representative input and output signal levels. Most consumer-goods high-fidelity ap-

Dictating Machine

Working portion of a transistor portable dictating machine shows turntable driven by rotating dog (above). Magnetic head (upper right) moves across paper magnetic disk to record in spiral pattern. Built by Tokyo Tsushin Kogyo, Ltd., the unit employs four transistors and runs from four flashlight cells. The microphone is also used as a playback receiver

ATLAS BUILT PLOTTING BOARD



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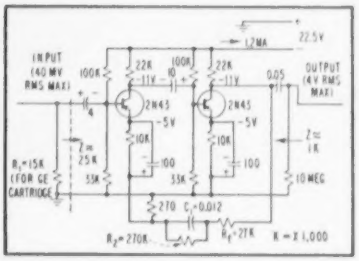
paratus is satisfactorily operated by a signal level in the order of 1 volt rms. A magnetic pickup cartridge, such as the widely used General Electric variable-reluctance unit, will produce an output voltage of approximately 10 millivolts for a lateral stylus velocity of 4.8 cm per sec. This velocity corresponds roughly to the average recorded velocity of many commercial long-playing 33⅓ rpm recordings. Instantaneous program peak velocities are approximately 10 db higher than average. Accordingly, a preamplifier voltage gain of 40 db (1 volt/10 millivolts) appears to be a reasonable choice.

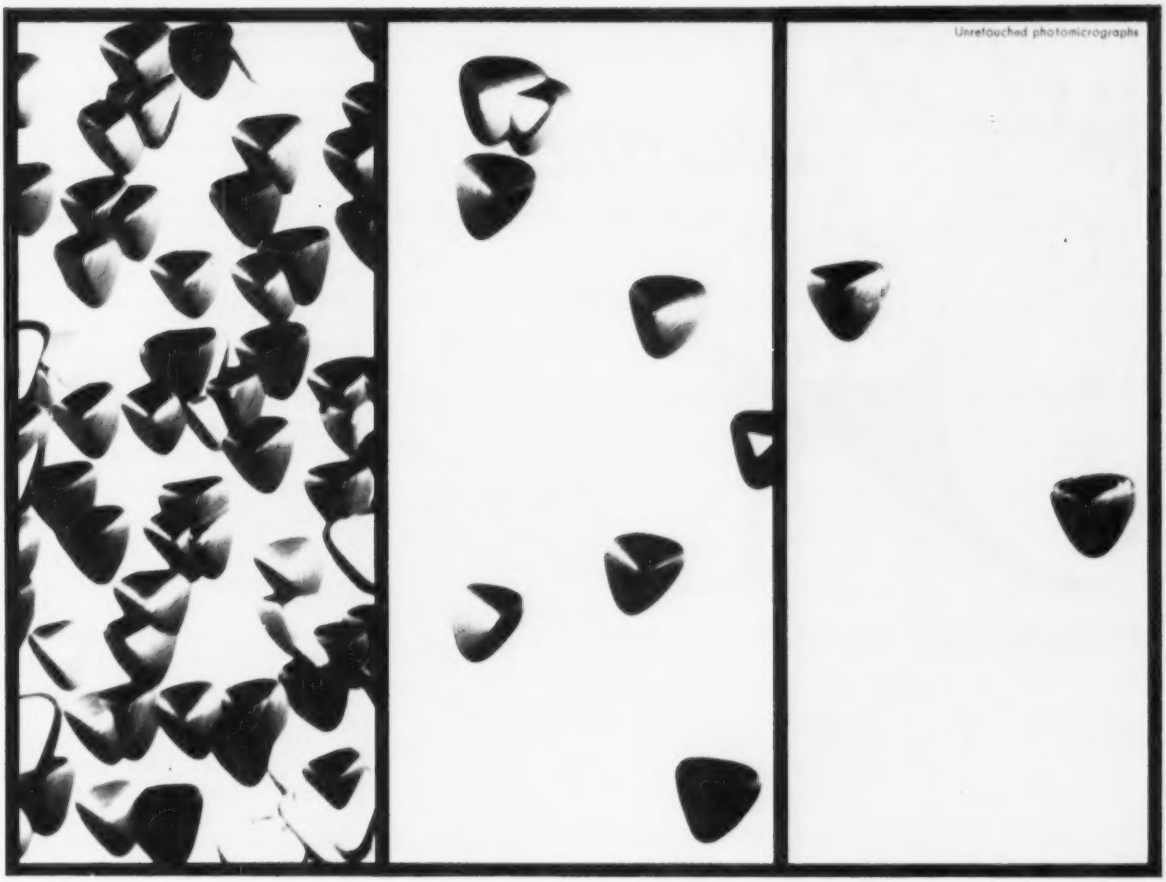
Two identical grounded-emitter stages shown in the circuit diagram are connected in cascade and operate from a collector supply potential of −22.5 volts. A substantial portion of the battery voltage is dissipated in the large emitter supply resistors. This practice insures good d-c stability of the circuit against variations in temperature and a high degree of circuit immunity to varying transistor parameters. Almost any junction transistor having a base-to-collector current multiplication of 30 or greater will operate satisfactorily in the circuit. Suitable types include 2N43, 2N104, 2N105 and 2N175.



Schematic circuit diagram of the transistor preamplifier with RIAA equalization

Battery voltage limits the output voltage swing of the amplifier. For all units tested, limiting occurs at an output level of approximately 4 v rms. Since the gain is 40 db, the maximum allowable input signal at 1 kc is 40 mv rms, or 56 mv peak. Total battery drain is 1.2 ma.

► **Equalization**—The feedback cir-

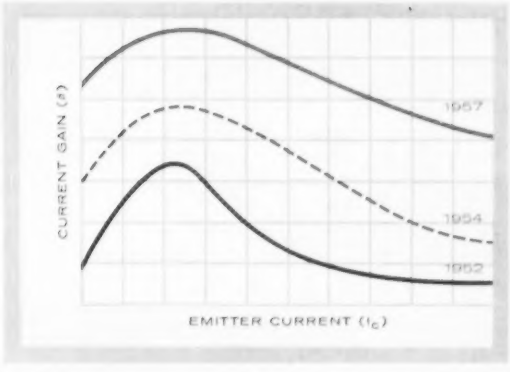


1952 Germanium crystals average many of these triangular "dislocations" or imperfections, here magnified 200 diameters.

1954 Processing improvements are bringing dislocations under better control, but density can be further reduced.

1957 Mechanized growing of CBS single crystals has uniformly minimized dislocations. Density is that of purest diamonds.

How more-perfect crystals improve transistor performance



BETA Note the higher Beta or current gain (other factors being equal) derived from today's perfected CBS germanium crystals. Beta is used as just one concrete example of many important performance factors improved by CBS-Hytron's better crystal processing methods.

How does CBS grow uniformly dislocation-free crystals with uniform resistivity? By precise checking of the "seed" for orientation and dislocation density. By growing the single crystal in smoothly operating, shock-proof mechanized furnaces. By automatic temperature control and a uniform temperature gradient throughout the growing period. Research and development advances like these are constantly at work to make CBS transistors better.

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Performance is measured by comparing standard ring-time with echo box ring-time. The echo box is coupled to the radar transmission line at the directional coupler or, with a pick-up horn, to the antenna. The ring-time provides a direct measure of standard performance.

A multivibrator with a variable pulse width is incorporated into the radar checker and set to match the required standard ring-time. The difference, if any, between this ring-time and actual ring-time is automatically related in decibels to standard overall performance.

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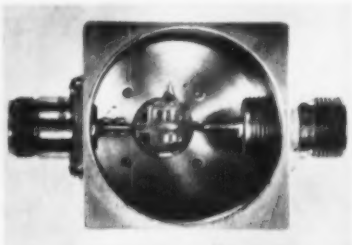
cuit consists of the elements shown in the lower part of the diagram. If the amplifier were designed for uniform frequency response the feedback impedance would comprise a pure resistor. This amplifier is intended to reproduce phonograph recordings from a magnetic pickup that is essentially a velocity sensitive device.

▶ **Standard** — Under these conditions amplifier transmission as a function of frequency should correspond to the present standard playback curve for lateral disc recordings as specified by the Record Industry Association of America. This nonuniform frequency characteristic compensates the pre-emphasis employed by the record manufacturer in the original recording. The curve is specified by three time constants (3, 180, 318 and 75 μsec) affecting the low, middle, and high frequency regions of the audio spectrum. It can be synthesized in the feedback amplifier by proper arrangement of the components in the feedback path.

The 318-μsec time constant is provided by C_1 and R_f. The 3,180 μsec time constant is the product of C_1 and R_2. The high-frequency time constant of 75 μsec is obtained by placing the appropriate value of resistive loading R_1 across the input connection to the amplifier so the series inductance of the pickup causes the desired amount of high-frequency roll-off. For a GE cartridge this resistance value should be 15,000 ohms as shown.

▶ **Performance**—Two preamplifier characteristics of interest are sig-

Micropotentiometer



Invented by Myron C. Selby of NBS Boulder Laboratories, the radio-frequency micropotentiometer shown can be used to measure a microvolt at 1 kmc

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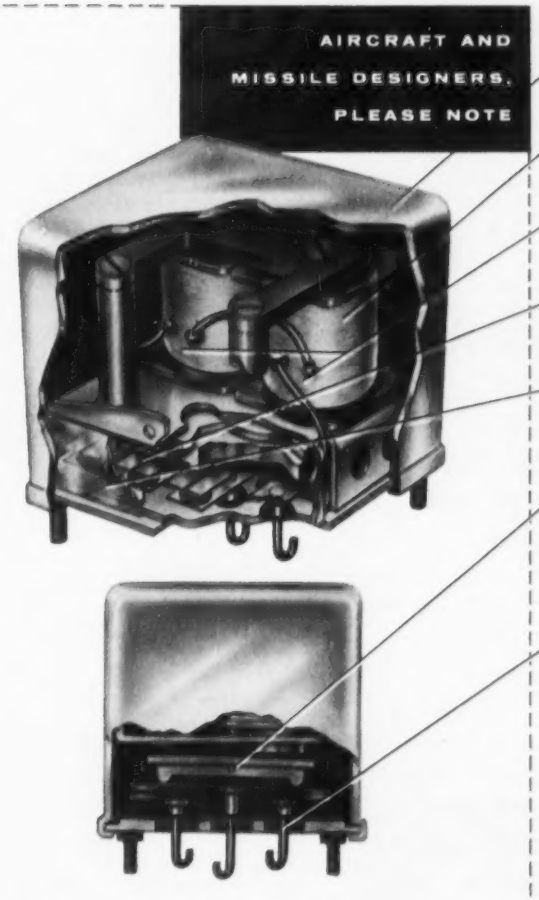

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nal-to-noise ratio and harmonic distortion.

In audio-frequency apparatus it is customary to specify noise output with respect to some reference output level appropriate to the particular equipment. For this amplifier the reference level is taken as 3 v rms. This is an output signal approximately equivalent to the peak instantaneous program level from an average long-playing recording reproduced by the typical pickup cartridge.

Relative to this 3-v reference level the average rms noise voltage for a sampling of 16 transistors of various types was 80 db down or 0.3 mv at the output of the preamplifier. The noise output of the preamplifier was therefore 70 db below the 1-v average signal level from a long-playing record. Such dynamic range is quite satisfactory for the reproduction of the usual recordings whose range is limited by surface noise to approximately 50 db. It is particularly true because no hum voltage need be generated in the preamplifier.

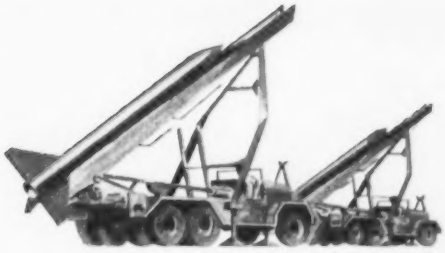
Harmonic distortion data were taken for the preamplifier at four frequencies and at three levels of signal output. In every case, distortion was less than 1 percent, ranging from 0.95 at 40 cps to a low of 0.12 at 400 cps with 1 v output.

The author acknowledges the assistance of friends at the Hazeltine Corp. in constructing, testing and describing laboratory models.

Radio Light

TRANSFORMATION of radio waves into luminous power has been reported from Rome, being attributed to Mario Cutolo of the University of Naples. A glass globe filled with rarefied air was placed between two metal plates, one connected with a receiving wire and the other with ground. The assembly was enclosed in a magnetic field formed by two magnets. Pulsed power of about 100 watts was transmitted at vhf a distance of 700 meters.

► **False Dawn**—The experiment is



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said to have followed the artificial-dawn hypothesis of V. A. Bailey of the University of Sidney, Australia, as a consequence of the theory of gyro-interaction in the ionosphere. Experiments in Italy are claimed to have shown that artificial dawn might be produced with even less power than had been supposed. Peak power emitted by the test transmitter was a matter of several kilowatts. The light produced was not obtained from fluorescent materials.

Low Power Drives P-A

By I. Dlugatch
Senior Engineer
Hycon Mfg. Co.
Pasadena, Calif.

Increased use of semiconductor devices has resulted in attempts at driving an r-f power amplifier with a transistor. No problem exists normally except where large power outputs are sought. Use of the transistor implies an intended conservation of prime power, which requires high efficiency in the power-amplifier stage. The latter requires high power sensitivity if there is to be any possibility of success for the design.

Plate efficiencies in the order of 80 percent can be achieved without

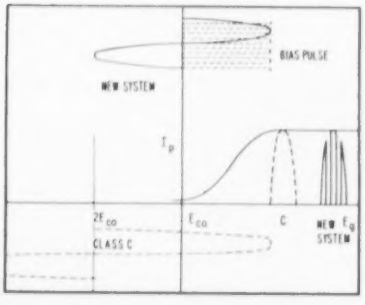
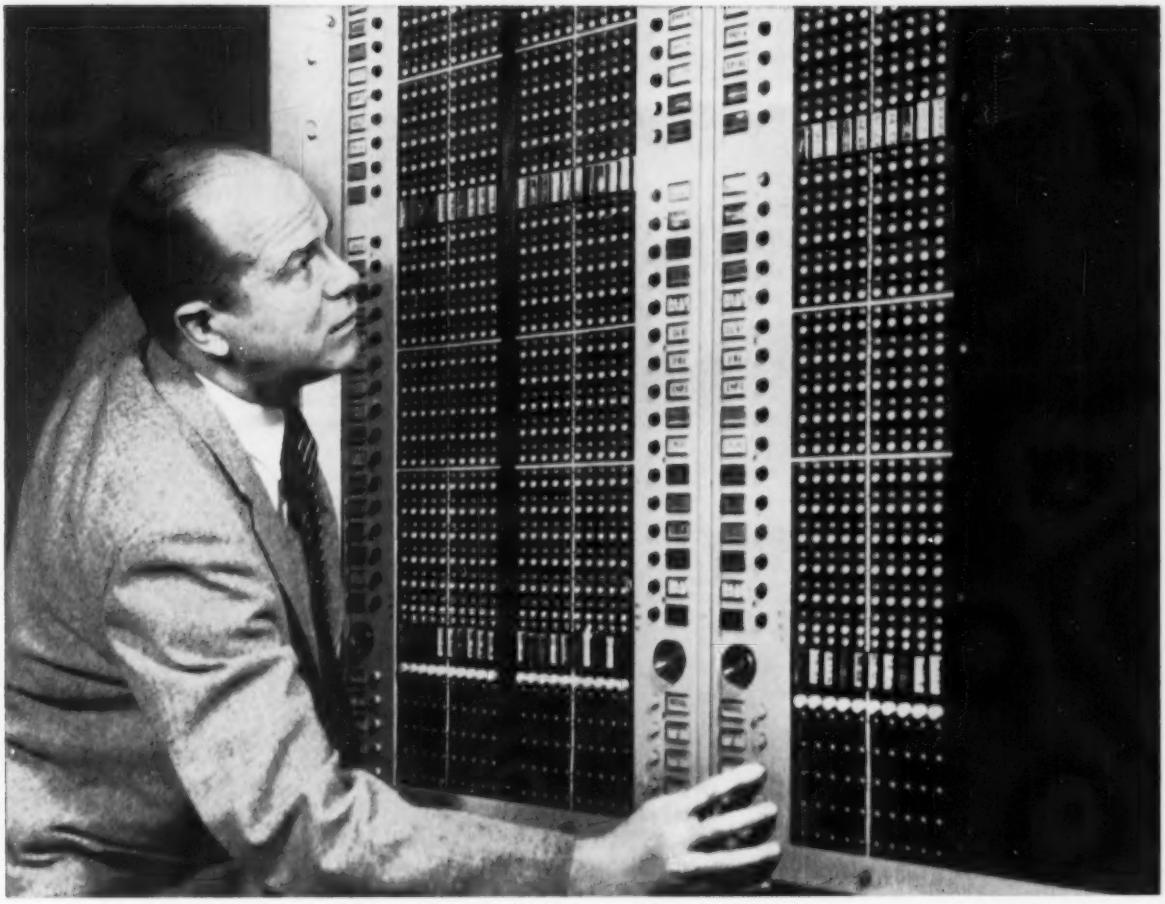


FIG. 1—Comparison of class C and new system

difficulty in a class C amplifier but higher efficiencies are desirable. The chief disadvantage of the class C amplifier is the necessity for high levels of driving power to achieve high efficiency. This is indicated by the dotted curves of Fig. 1. The transistor as a driver is generally limited by low power



Bell Laboratories engineer Cyril A. Collins, B.S. in E.E., University of Washington, demonstrates new TV switching control panel for black and white or color. Complex switching connections are set up in advance; in a split-second a master button speeds dozens of programs to their destinations all over the nation. Special constant-impedance technique permits interconnection of any number of broadband circuits without picture impairment.

Telephone science speeds TV enjoyment

Telephone science plays a crucial part in your TV entertainment. An interesting example—one of many—is the latest TV switching center developed at Bell Telephone Laboratories.

Switching centers control the transmission of programs which come to your local TV station over Bell System facilities. To be available exactly on cue, programs must be switched at high speed and with very great accuracy.

To create the new switching center Bell Laboratories engineers borrowed from the switching control art which handles your dial telephone calls. They developed a special control panel which puts complex switching patterns within the easy grasp of one man. By pushing buttons, he sets up—and double-checks—forthcoming network changes far ahead of time. On cue he presses a master button which sends the programs racing to their respective destinations around the nation.

To connect the broadband circuits, the Laboratories engineers developed a new video switch which operates on a constant-impedance principle. The new switch permits the interconnection of any number of circuits, without the slightest impairment of transmission quality.

Thus the technology which serves your telephone also works for your TV enjoyment.

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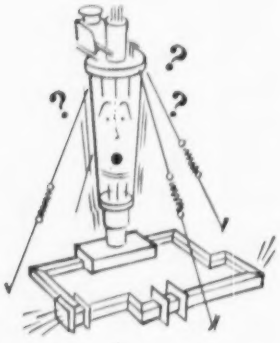

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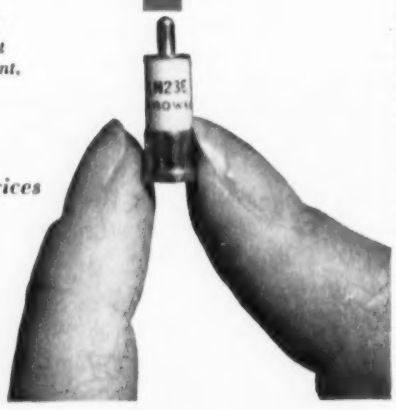

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output particularly at frequencies above 5 mc.

Present day transistors are usable for this application by means of the system described below. The scheme involves negatively modulating the p-a grid with a frequency several times higher than that being amplified, as shown in block diagram form in Fig. 2.

This method attains the goal of reduction in driving power and increases the efficiency of the p-a stage. Evaluation of the scheme is simplified by making several assumptions. First, assume that all plate current pulses discussed will have the shape of half a sine wave. Second, in the class C operation used as a basis of comparison, assume that its bias is twice cutoff so the result operating angle is 120 degrees.

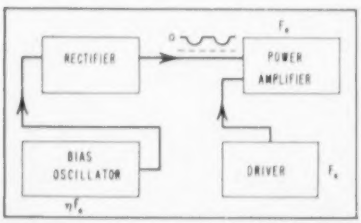

FIG. 2—Negative modulation of grid with high frequency

In the suggested system of Fig. 2, a half-wave rectifier changes the output of the bias oscillator to produce a negative, half-sine wave pulse of sufficient amplitude to cut off the p-a. This bias pulse appears at the grid of the power amplifier with a repetition rate of n times the frequency of the driver stage. It permits the p-a to conduct during only half the time it would normally conduct.

Assume the p-a to be biased at cutoff and plate current pulse amplitude maintained at the same level as for the class C system as shown by the solid lines of Fig. 1. The mean effective operating angle is now 90 degrees, mean referring to variations with phase shifts.

If a pentode is used for the p-a, plate supply voltage can be increased to maintain the same d-c input as for the class C system

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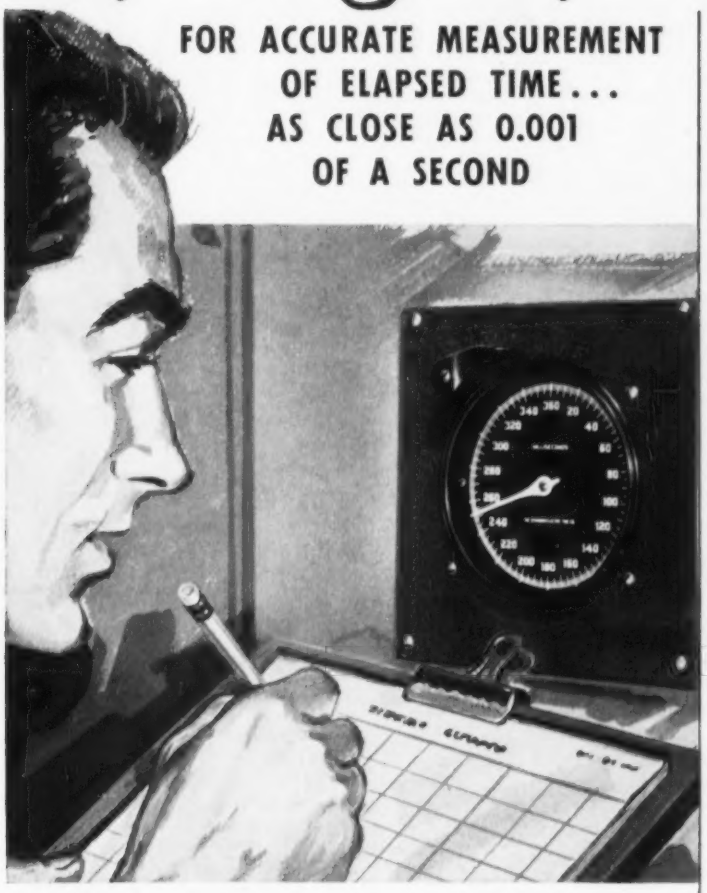

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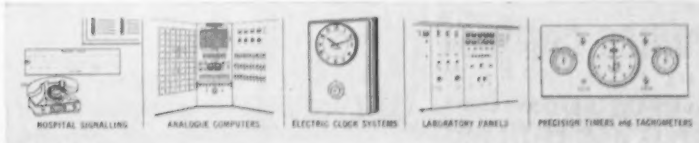
S-60	1/5 sec.	60 min.	±.1 sec.
SM-60	1/100 min.	60 min.	±.002 min.
S-10	1/10 sec.	1000 sec.	±.02 sec.
S-6	1/1000 min.	10 min.	±.0002 min.
S-1	1/100 sec.	60 sec.	±.01 sec.
MST	1/1000 sec.	.360 sec.	±.001 sec.
MST-500	1/1000 sec.	30 sec.	±.002 sec.



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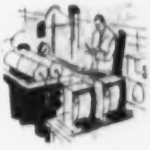

▲ At General Electric Co. — Trumbull Division — measuring operating time of circuit breakers.

◀ At American Brass Co. — indicating metallurgical analysis in Direct Reading Spectroscope by Baird Associates.

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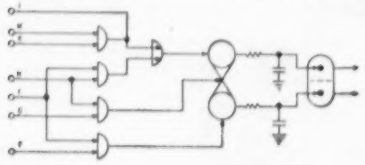
EECO Data Sheet

- Gray-to-binary code conversion with new EECO Computer-Series plug-in (Y-103).
- Small Engineering Company Organization—a philosophy and method for tailoring operating procedures.

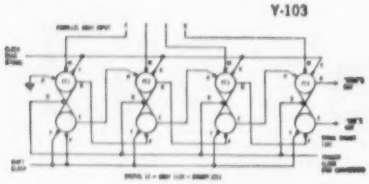
Y-103

Gray-to-binary Code Converter

Included among the many functional circuits available in EECO's new Computer-Series plug-ins is a Flip-Flop – Shift Register Element (Y-103) that is



Y-103



adaptable for use as a composite Gray-to-binary code converter and shift register. For this use, the Gray number is read into the shift register in parallel form (for example, from a code wheel or flip-flop register), converted internally to a binary number, and then shifted out in serial form.

In the schematic illustration, the input Gray number is 1110, corresponding to decimal 11 and binary 1011. The Gray-to-binary conversion is based on the rules that:

1. The most significant digit is identical in each code system.
2. Each succeeding Gray digit is complemented if the preceding *binary* digit is a 1, or repeated if the *binary* digit is a 0.

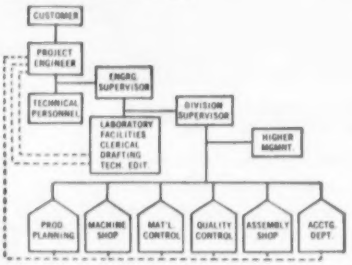
Trigger clock (conversion) pulses cause the Gray-to-binary conversion and must be one less in number than the number of digits in the Gray code. After conversion, the binary number is shifted out serially by shift clock pulses.

More detailed information on this and other applications of EECO Standard-Series and new Computer-Series plug-ins is available in Catalog No. 856-A. Write for your copy.

Tailor-Making a Company Organization

Each of the two classical types of company organization – "Project" and "Departmental" – has weak as well as strong points. By combining the strong and eliminating the weak points of the two (insofar as practicable within the limits imposed by the type of company activities and objectives involved) it is possible to evolve a third system superior to either of the original two.

This complete analysis and integration process is described in detail in the reprint of a talk delivered by T. W. Jarmie, president of Engineered Electronics Co. and a director of Electronic Engineering Co. of California, before the Professional Group on Engineering Management of the IRE. The final operation chart developed by this process (illustrated below) reflects the operating procedure that has proven so successful at EECO.



Although this talk was first delivered in 1955, so much recent interest has been shown in the subject that reprints of the paper have again been made available. Ask for Reprint J-2.

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without negating previous assumptions.

Calculations can then be made using

$$I_{av} = \frac{2\,I_{max}\,t}{\pi\,T}$$

$$\text{and } I_{rms} = I_{max}\sqrt{\frac{t}{2\,T}}$$

where t = pulse width
T = pulse period

For class C

$$\text{d-c power} = I_{av}\,E_{BB1} = \frac{2\,I_{max}\,120^\circ\,E_{BB1}}{360^\circ\,\pi} = \frac{2\,I_{max}\,E_{BB1}}{3\,\pi}$$

For the new system

$$\text{d-c power} = \frac{2\,I_{max}\,90^\circ\,E_{BB2}}{360^\circ\,\pi} = \frac{I_{max}\,E_{BB2}}{2\,\pi}$$

Since the two powers are equal

$$E_{BB1} = \frac{4\,E_{BB1}}{3}$$

That is, the d-c voltage for the new system needs to be 33 percent higher. Likewise, for the power outputs

$$\frac{P_1}{P_2} = \frac{I_{rms1}\,E_{BB1}}{I_{rms2}\,E_{BB2}}$$

or the power output for the new system is

$$P_2 = \frac{\left(I_{max}\sqrt{\frac{90}{720}}\right)\left(\frac{4}{3}\,E_{BB1}\,P_1\right)}{\left(I_{max}\sqrt{\frac{120}{720}}\right)E_{BB1}} = \frac{4\sqrt{90}\,P_1}{3\sqrt{120}} = 1.15\,P_1$$

That is, 15 percent more power output has been realized.

The higher efficiency now possible, though extremely desirable, is not the most significant factor favoring this plan. Class C amplifiers are theoretically capable of 100-percent efficiency and can achieve practical values of 90 percent. The additional prime power to operate the bias signal source may further decrease the advantage.

► **Driving Power**—The real merit of the proposed system is in the reduction in driving power required

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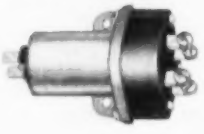

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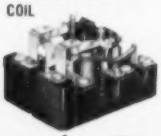

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to obtain such high plate efficiencies. This is demonstrated in Fig. 1. With this method it is now possible to utilize transistors as drivers and oscillators where their power capabilities previously prevented it.

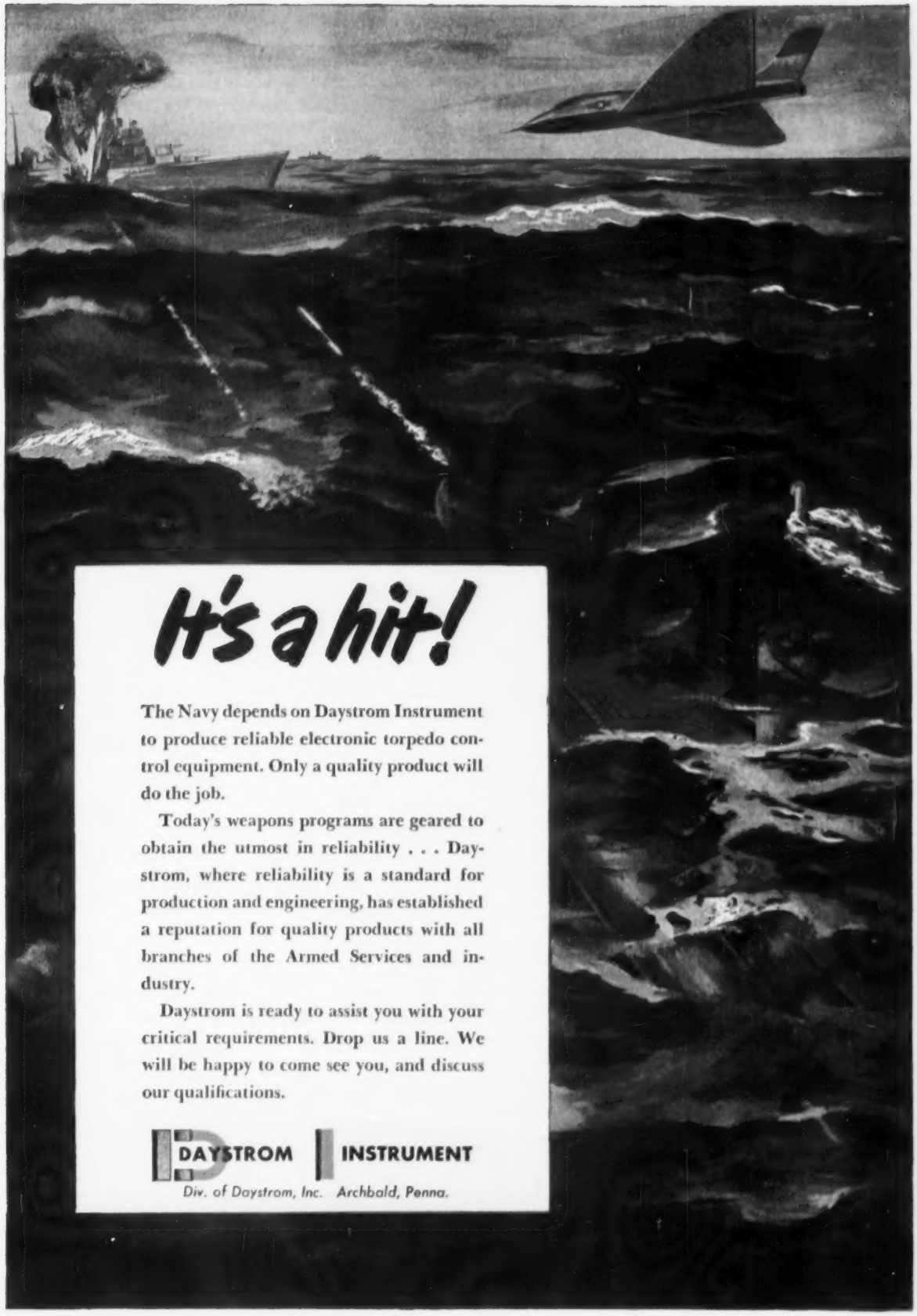
Audio modulation at the grid of a power amplifier is an obvious comparison. Such modulation will increase the efficiency of the stage just as the negative bias described above but this is only in terms of the modulated wave. The carrier efficiency is actually reduced by a factor of two. That is, twice as much driving power is necessary as with the unmodulated class C stage.

The proposed system does not preclude the modulation of the p-a by any of the known modulation methods.

The bias oscillator, since it is not required to provide substantial power, can be a transistor, if frequency limitations permit, to minimize its prime power requirements. High stability is not vital except that rapid variations in frequency are to be avoided to prevent possible audio-frequency modulation. Deliberate sweeping of this oscillator could provide tone modulation if so desired. In some cases, the oscillator is not necessary because a high-frequency signal is avail-

Starting Point

Developed by John Ambrose Fleming in 1904, the diode shown above constitutes the first practical application of the Edison effect and became the forerunner of basic detectors and rectifiers. It is part of a display by International Rectifier Corp.



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MODELS

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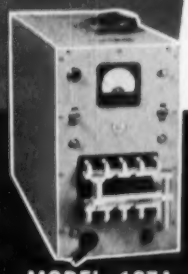
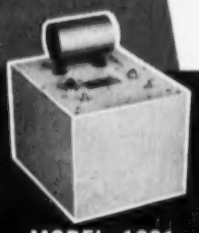
Charging outputs from 100,000 to 200,000 ampere-turns through plug-in transformers, up to 3600 watt-seconds using wire-wound fixtures. Adapters for multi-pole rotors, rod, bar, ring and various other shapes available. Designed for continuous production use with low power consumption. Price of basic unit is less than $2100.



MODEL 107A

A basic condenser discharge unit for most medium size magnets, the Model 107A provides ranges of 12,000 and 24,000 ampere-turns. It is capable of saturating most instrument magnets, including the new core type mechanisms, using adapters or wire-wound fixtures. Designed for continuous duty. Operates from 115-volt, 60-cycle line. Price $530.



MODEL 1221

A low cost, condenser discharge unit employing novel, plug-in wire-wound type charging fixtures, the Model 1221 is designed for the user of small magnets. Its 10,000 ampere-turn output will saturate about 2" of Alnico V. Charging cycle rate is approximately 3 seconds, continuous duty, operates from 115-volt line. Price $180.

Performance of all models is rigidly guaranteed. Prices are net f.o.b. Boonton, N.J. and subject to change without notice.

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able elsewhere in the equipment.

No particular value of n is preferred but the same precautions are to be observed that would apply in any mixer application where beats may cause difficulties.

Excessive sideband generation might reduce the efficiency to a point at which this method would be impractical. Therefore, the Q of the p-a tank circuit must be high to increase the rejection. The use of harmonic filters is definitely recommended as a preventive measure. The choice of as high a value for n as possible will reduce this disadvantage.

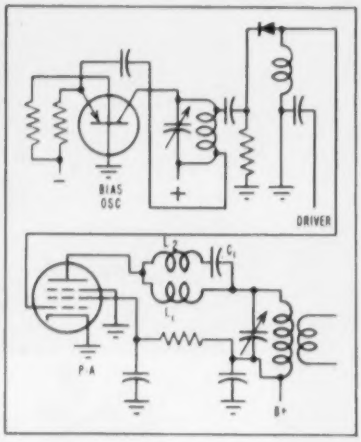

FIG. 3—Typical circuit shows the new system

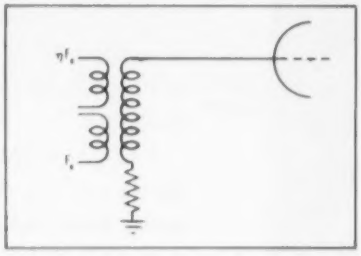

FIG. 4—Alternate circuit that eliminates rectifier

Figure 3 is a typical circuit for the system described. Components L_1, L_2 and C comprise a harmonic suppression filter. Applications are not limited to transistors, alone, either for the bias oscillator or the driver.

Figure 4 is an alternate scheme eliminating the rectifier. Other circuits will suggest themselves for

Roving reporter, half mile under the sea

Exploring at the bottom of a 2000-foot coaxial cable, "Project Fisheye" now roams the ocean depths collecting information for our Navy about sunken vessels, currents, and mysterious undersea life. Its findings are televised to observers on the surface.

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*duPont trademark for its tetrafluoroethylene resin

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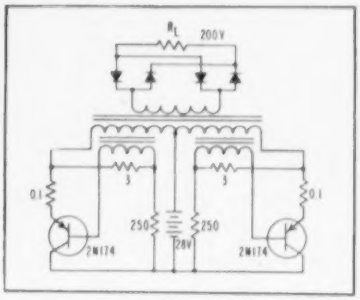
applying this idea toward reduction of the operating angle without increasing the drive.

D-C Transformer

VOLTAGE step-up from storage battery to potential suitable for average electron-tube plate supply is generally accomplished using a vibrator power pack. An interesting function for certain types of transistors is that of generating an alternating voltage that can be



Circuit of the d-c/d-c converter

stepped up and subsequently rectified by semiconductor diodes.

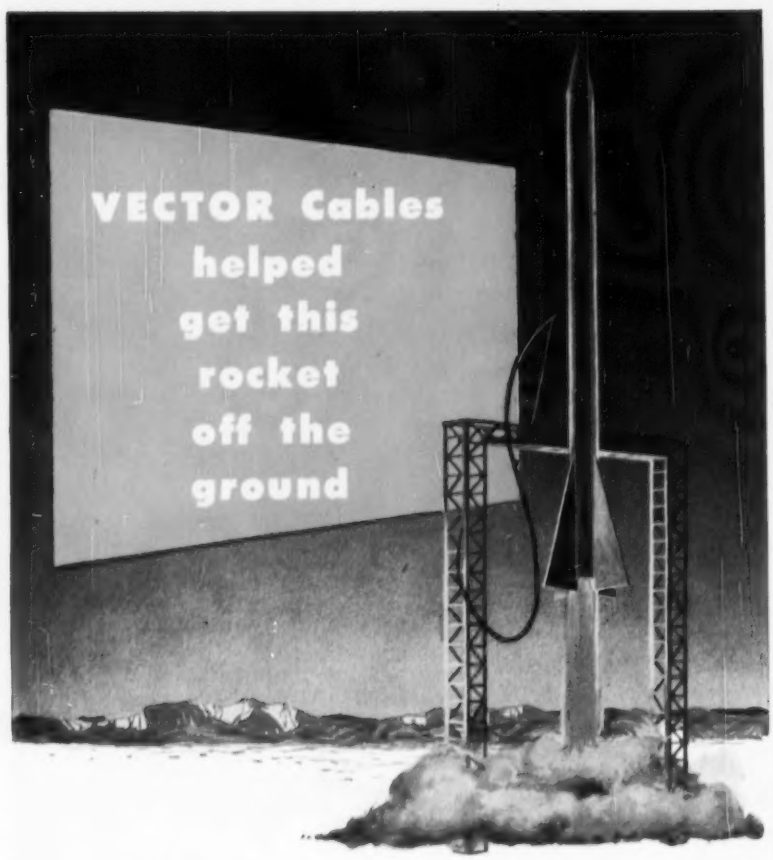
Low saturation voltage of the type shown in the circuit diagram reduces the internal power dissipation in the converter application. The resultant small amount of self-heating permits a small heat sink and small size of the package.

Circuit and information have been furnished by Delco Radio Division of Kokomo, Ind.

Standard Calls

CALL LETTERS have been assigned for new standard frequency stations of the National Bureau of Standards, Boulder Laboratories. A frequency of 10 kc is proposed for transmission from a location near Boulder, Colorado using the call sign WWVL.

Another call sign WWI is for the frequency of 30 mc, an experimental c-w transmission from a station at Havana, Illinois.



In the overall picture of a rocket launching, a cable may appear to be a rather small detail, but as every design engineer knows, the success of the project depends on the inter-connecting cable system . . . and here's where the value of Vector's engineering staff and modern manufacturing facilities have been established.

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MODEL C-881M:	125-325 VDC, 0-800 MA ... 345.00	MODEL C-881:	125-325 VDC, 0-800 MA ... 315.00
MODEL C-882M:	325-525 VDC, 0-800 MA ... 390.00	MODEL C-882:	325-525 VDC, 0-800 MA ... 360.00

400 MA MODELS **NEED ONLY 5¼" OF PANEL HEIGHT!**

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MODEL C-481M:	125-325 VDC, 0-400 MA ... 274.50	MODEL C-481:	125-325 VDC, 0-400 MA ... 244.50
MODEL C-482M:	325-525 VDC, 0-400 MA ... 289.50	MODEL C-482:	325-525 VDC, 0-400 MA ... 259.50

200 MA MODELS **NEED ONLY 5¼" OF PANEL HEIGHT!**

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MODEL C-281M:	125-325 VDC, 0-200 MA ... 189.50	MODEL C-281:	125-325 VDC, 0-200 MA ... 159.50
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Production Techniques

Edited by JOHN MARKUS

Drilling Holes in Servo Housings Three-at-a-Time

THREE No. 56 holes are simultaneously drilled 120 degrees apart in the stainless steel housing of a servo motor while the operator holds the housing in position on a centering fixture, in a drilling setup developed by the Mechatrol Div. of Servomechanisms, Inc., Westbury, N. Y. The new setup has cut drilling time to one-third and greatly reduced breakage of the small drills.

Brackets hold three automatic drill heads (made by the Dumore Co., Racine, Wisc.) on a cast iron sheet which serves as the top for the drilling table. A push button energizes the electric drills of all three motors simultaneously to drive the drill chucks and drive the fans of the air-actuated drill feeds. The drills advance automatically through hardened bushings in the locating fixture.

A lever bolted to the feed slide of one of the motors actuates a counter to indicate the number of holes drilled. The drills are changed routinely after 125 motor housings have been drilled.

Operator holds motor housing in locating fixture with left hand while pressing start button to initiate drilling of three holes simultaneously in type 303 stainless steel. Motor fixture is adaptable to take BuOrd housing sizes 11 to 20

Waveguide Bender Uses Clockspring-Steel Mandrel

BY R. R. PALMISANO
Mechanical Engineer
and
A. SHERMAN
Model Shop Foreman
Diamond Ordnance Fuze Labs
Washington, D. C.

WAVEGUIDE TUBING bent to an inside radius as small as ¼ inch is often needed in guided missiles and other applications where space is critical. The device is capable of bending waveguide tubing in either plane through a range of ¼ inch to 24 inches inside radius while maintaining the internal dimension tolerances of the original tubing.

▶ **Requirements**—To be able to form sharp bends that will hold their shape after removal of forming stresses, the flow must take place within the plastic range of the material. The material must have an ample plastic range or region between the yield point and breaking point, and the waveguide tubing must be properly prepared prior to forming. Preparation involves two operations: (1) Drawing a broach through the tubing as in Fig. 1 to square the inside corners of the tubing and to size it, thus permitting a flexible mandrel to be later drawn through the tubing without obstruction; (2) an-

Typical H-plane and E-plane waveguide bends formed on machine

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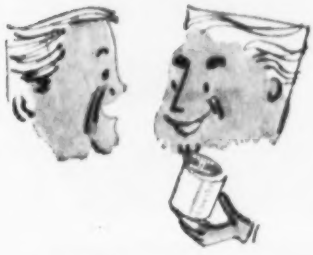
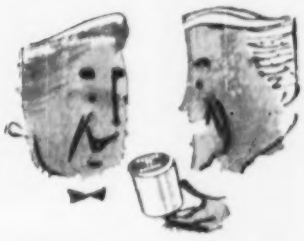
"Nothing like Kester Solder, Fred, for keeping costs in line."

"Our girls swear by Kester, Bert; they claim soldering is much easier."

"Kester 'Resin-Five' Core Solder is the choice for our production, Paul."



"Our work goes much faster now, Bill, since we switched to Kester Solder."



"We had a tough soldering job, Harry, but Kester engineers licked it in a hurry."

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HOW THE WORD GETS AROUND

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nealing the tubing to extend its plastic range (2S aluminum tubing is annealed at 700F, and 90-10 commercial bronze or brass tubing is annealed at 1,100F in an inert gas atmosphere).

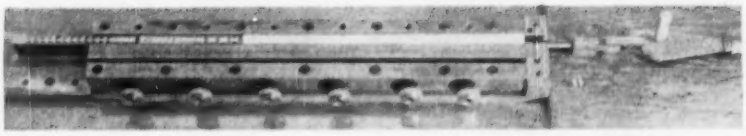
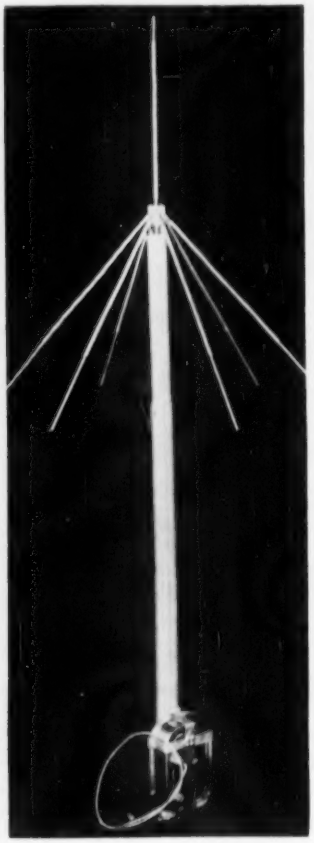


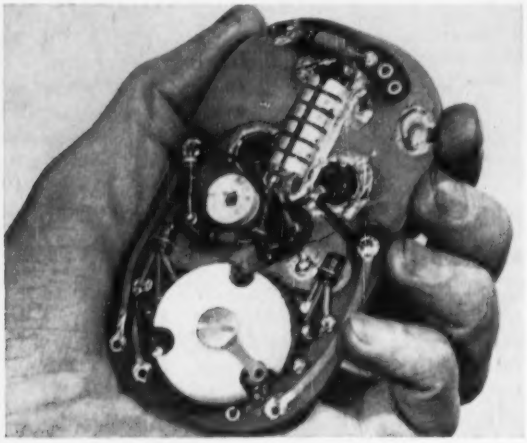
FIG. 1—Cable at right pulls sizing broach through waveguide tubing in preparation for bending. Vise clamp having six knurled screws holds tubing

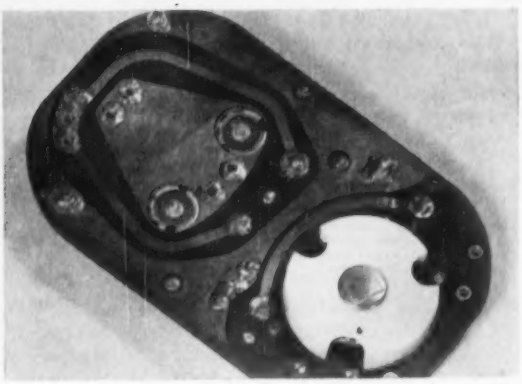
▶ **Mandrels**—In forming radii of 6 inches or larger, fine-grain foundry sand is rammed into the tubing to prevent the thin walls from collapsing. Low-temperature fusible alloys or rosin may also be used as internal support. For bends of less than 6 inch radius, a mandrel made up of the proper number of leaves of 0.005-inch thick clock-spring steel is used to fill the inside of the tubing. With the piece to be bent held in the vise clamp as in Fig. 2, the spring-steel mandrel is oiled and drawn through the tubing by means of a cable fastened to the broach-pulling head of the

Design of the Month: MISSILE-LOCATING BEACON

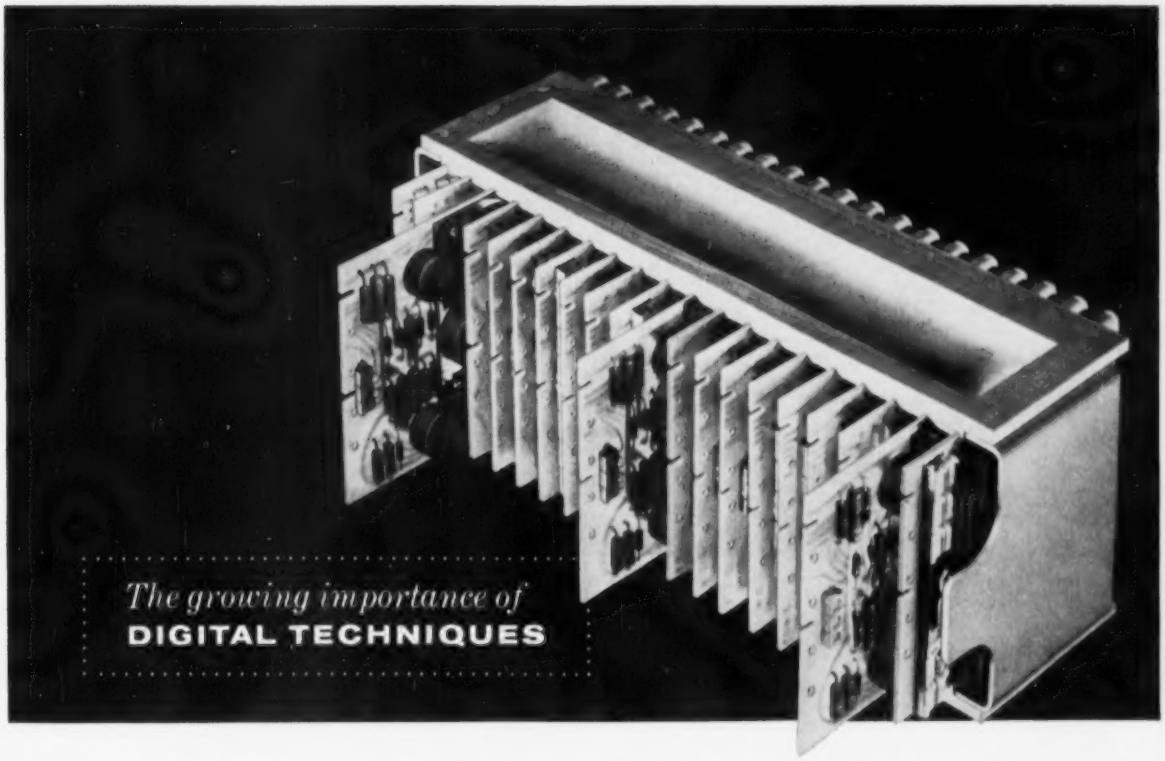


Compact uhf transmitter in sardine-can housing is combined with antenna opened automatically by explosive charge, to give beacon for locating and recovering guided missiles test-fired over water. Collapsed height is only 12 inches. After missile hits water, timer sets off explosive squib in combustion chamber at bottom of antenna, producing gases that force out telescoping antenna and ground plane tubes. Open 3-ft antenna has omnidirectional pattern, with cone of silence overhead for pinpointing location from search plane. Battery pack in separate case gives 24 hours of operation from 1.5 v and 7.5 v units. Sardine can is silver-plated





Etched coil and wiring on both sides of Kel-F laminate give high-efficiency modified Colpitts oscillator having range of 25 miles at 280 to 322 mc. Subminiature 6029 triode oscillator operates from transistorized power supply using two 2N132 transistors and toroidal power transformer (set into large hole in laminate). Resulting 1,000-cps unfiltered square-wave output is applied directly to tube to give tone modulation. Kel-F or Teflon pieces center unit in sardine can, cover of which is soldered in place. Beacon was developed by Electronics Division of Fairchild Controls Corp., subsidiary of Fairchild Camera and Instrument Corp.



As recently as ten years ago it was just becoming evident that digital techniques in electronics were destined to create a new and rapidly growing field. Today, incorporated in electronic computers and other equipment, they constitute one of the most significant developments in scientific computation, in electronic data processing for business and industry, and in electronic control systems for the military. In the near future they are expected to become a major new factor in industrial process control systems.

The digital computer for scientific computation is becoming commonplace in research and development laboratories. Such machines range from small specialized units costing a few thousand dollars, to large general purpose computers costing over a million dollars. One of these large computers is a part of the Ramo-Wooldridge Computing Center, and a second such unit will be installed the latter part of this year. The digital computer has not only lightened the computation load for scientists and engineers, but has made possible many calculations which previously were impracticable. Such computers have played a major role in the modern systems engineering approach to complex problems.

Electronic data processing for business and industry is now well under way, based on earlier developments in electronic computers. Data processors have much in common with computers, including the utilization of digital techniques. In this field, teams of Ramo-Wooldridge specialists are providing consulting services to a variety of clients on the application of data processing equipment to their problems.

The use of digital techniques in military control systems is an accomplished fact. Modern interceptor aircraft, for example, use digital fire control systems. A number of Ramo-Wooldridge scientists and engineers have pioneered in this field, and the photograph above shows a part of an R-W-developed airborne digital computer.

These, then, are some of the aspects of the rapid growth which is taking place in the field of digital techniques. Scientists and engineers with experience in this field are invited to explore openings at The Ramo-Wooldridge Corporation in:

Automation and Data Processing
Digital Computers and Control Systems
Airborne Electronic and Control Systems
Guided Missile Research and Development
Electronic Instrumentation and Test Equipment
Communication Systems

The Ramo-Wooldridge Corporation

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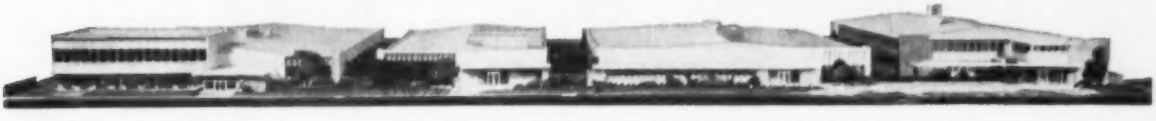

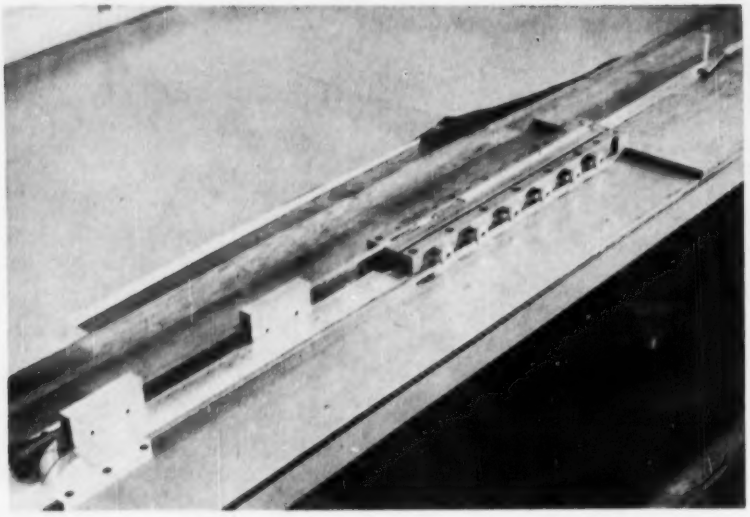

FIG. 2—Drawing mandrel through sized tubing held in vise clamp. Mandrel is made up of number of lengths of clock-string steel

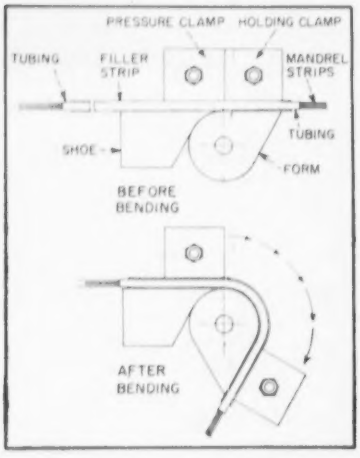

FIG. 3—Setup for bending tubing

horizontal broaching machine supplying the force.

▶ **Forming Procedure**—After disconnecting the drawing cable and removing the mandrel-filled piece from the holding vise, it is clamped against a form of desired radius as in Fig. 3. The shoe fills the unsupported area opposite the pressure clamp, thus supporting the material on the side opposite the point of greatest pressure. The two 0.015-inch-thick spring-steel filler strips on either side of the material serve to prevent scoring or marring the outer walls of the tubing and to span any gap which may exist between the shoe and the form.

In forming, there is no relative motion between the form, the part being formed and the holding clamp as they move about the center of the table. The stationary pressure clamp takes the thrust of the free end of the tubing being formed, forcing the tubing to take the shape of the form as it rotates. The shoe and top plate in Fig. 4 help insure smooth bends by backing up the thin-walled material. Since the material has been annealed to a high degree of ductility, there is very little springback in

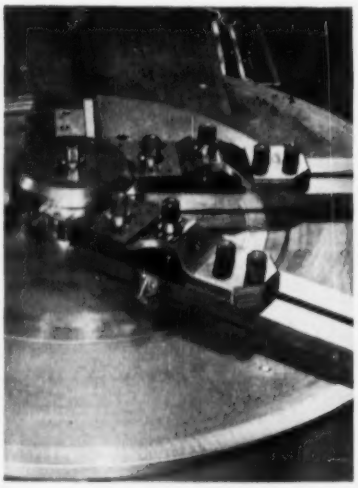

FIG. 4—At the start of bending operation: moving arm at right foreground is manually moved clockwise to bend tubing held down by circular top plate at center of table

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Compact, reliable system features high output with simplicity of design

SPECIFICATIONS:

Output: 650 watts, 5000 cycles, 115 volts, single phase
35 watts, 400 cycles, 115 volts, single phase
0.6 gal. per min. at 2000 psi hydraulic pressure

Regulation: ± 5% voltage and frequency

Duration:	27 seconds
Weight:	9.5 pounds
Size:	6.14 in. diam., 6.74 in. long

Ground power: compressed air

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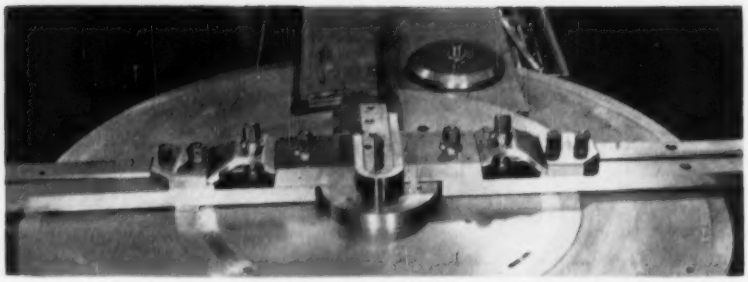

FIG. 5—Rectangular waveguide tubing formed into 180-deg bend, with top plate removed after bending to show bend

forming (only about 1 deg).

After the arm bearing the holding clamp is swung around to the desired degree of bending, as in Fig. 5, it is locked in position by means of a cam lock on its underside. The steel mandrel is then withdrawn from the tubing by a cable which connects the mandrel clamp to the broach-pulling head of the horizontal broaching machine supplying the necessary force for extraction, as in Fig. 6. Upon releasing the pressure and holding clamps and sliding them free of the work, the completed bend can be removed from the machine.

▶ **Accuracy**—Internal dimensions throughout the bends are held to within the original ± 0.003-inch commercial tolerance. The critical internal surfaces are not marred or scored due to bending. Consistent and small springback makes possible accurate angular reproducibility.

The electrical performance of waveguide bends formed by this machine is satisfactory. Sections of waveguide containing various E and H-plane bends generally showed a vswr of 1.04 or less over a frequency range of 1,000 mc. The maximum vswr encountered was 1.08, which occurred only in some isolated cases and within a very narrow frequency band.

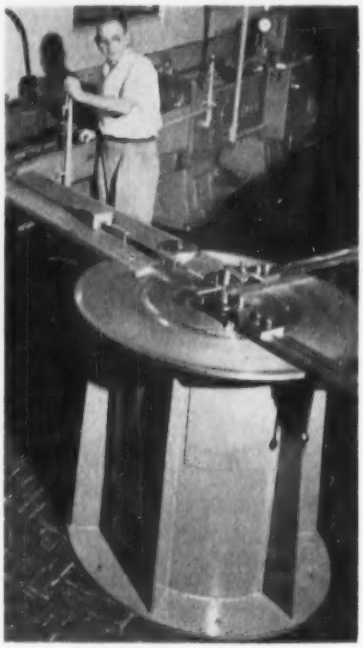

FIG. 6—Pulling mandrel out of tubing after 90-deg bend with ¼ inch-radius

Although this waveguide bender is not at present intended for high production requirements, it can produce accurate bends through a wide range of radii and a variety of angles. It is possible to bend rectangular waveguide tubing accurately in either plane up to 120 deg for ¾ inch to 1 inch radius and 180 deg for 1 to 24 inch radius.

Chrome-Plated Mold for Connector Potting

CHROME-PLATED STEEL molds solved a major problem in connection with potting of electrical connectors on missile and aircraft wiring harnesses at Chance Vought Aircraft. A mold of aluminum was used formerly to form the polysulphide plastic resin base around the connectors. The resin either stuck to the metal and had to be scraped off or, if a petrolatum coating was smeared inside the mold, this had

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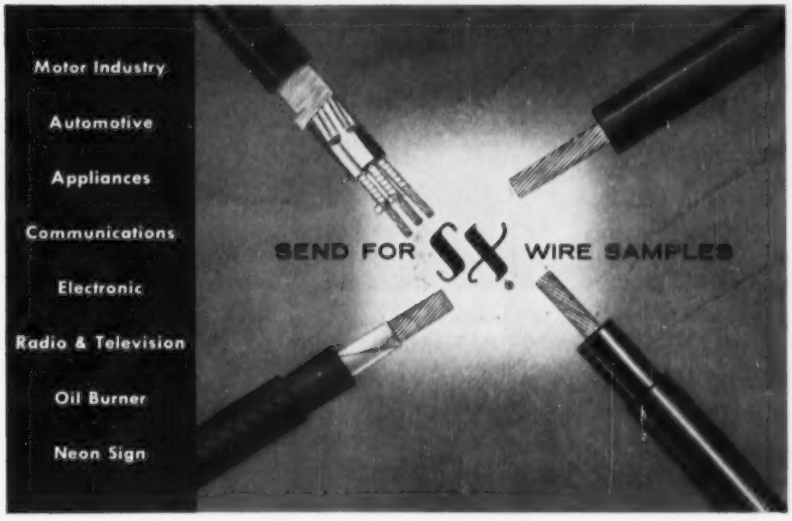

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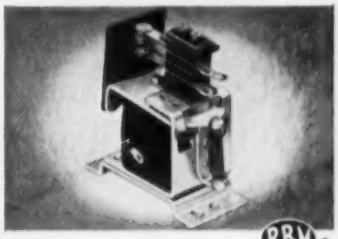

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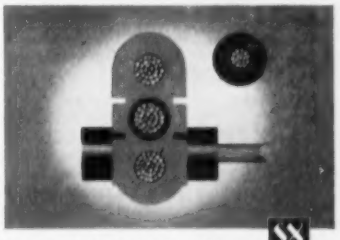

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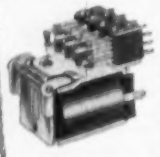

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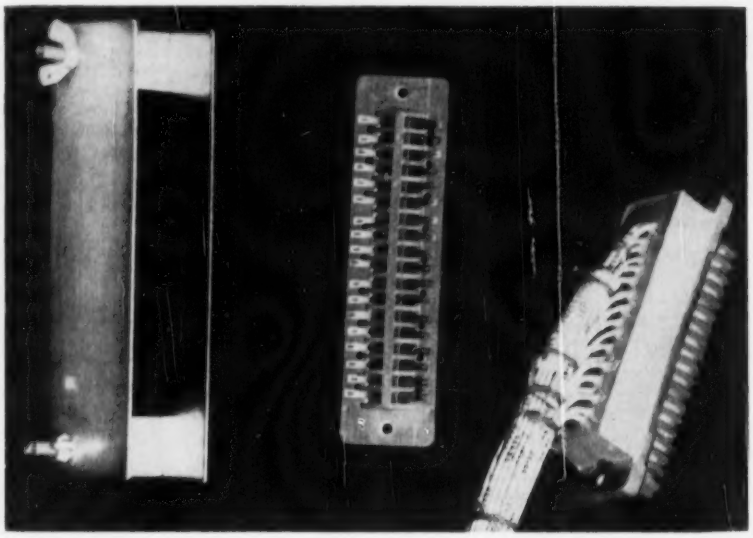


After cable wires have been connected to connector at center, assembly is placed in chrome-plated mold at left and resin is poured to give final potted unit at right

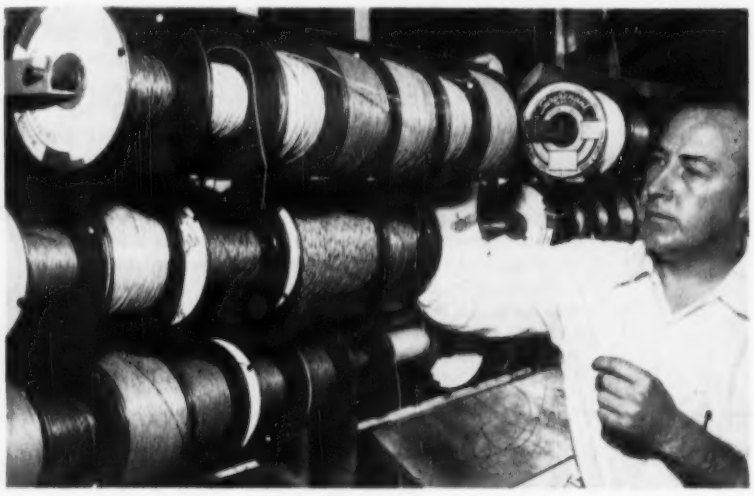
to be wiped off after each operation.

The resin does not stick to the new molds. To keep the molten resin from leaking through the mold and fouling up the electrical contacts on the open face of the connector, the mold with the connector in it was dipped in cellulose acetate butyrate plastic. This formed a cap which sealed off the exposed portion and could be easily peeled off and remelted after each operation.

The new method of potting the connectors saves 10 minutes work on each dipping and eliminates messy molds.

Spool Guard Stops Snarls on Wire Rack

STRIPS OF SHEET ALUMINUM pressing lightly against the rims of spools on wire racks solved the problem of tangles in Lenkurt's San Carlos, Calif. plant. Formerly, when an operator at a cable har-



Strips of aluminum over rows of spools stop overrun and prevent wire from slipping over rim onto adjacent spool when operator reaches over harness board to pull down and cut off length

The oscilloscope that holds traces indefinitely

HUGHES 104 MEMO-SCOPE* OSCILLOSCOPE

SINGLE OR SUCCESSIVE writings can be retained as permanent transients by the 104 MEMO-SCOPE Oscilloscope until intentionally erased. Stored traces may be almost instantaneously erased by front panel push button or external switch.

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For additional information or demonstration of the new Model 104, write to HUGHES PRODUCTS • MEMO-SCOPE OSCILLOSCOPE
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• Protects meter and entire internal circuit against accidental burn-outs.
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This instrument is available in two models: Industrial Model 455 . . . has a sensitivity of 20,000 ohms per volt AC or DC; Audio Model 456 . . . has a sensitivity of 20,000 ohms per volt DC and 1,000 ohms per volt AC. The 456 also includes DB ranges and provision for output measurements.

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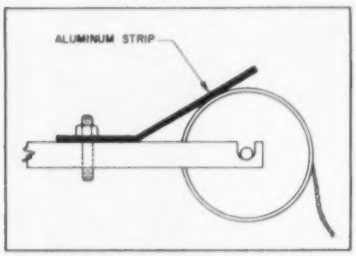
ness board clipped a length of wire off one of the spools above her working position, the free end of the wire would often unwind enough to fall over the rim of the spool and tangle with the wire on the next adjacent spool. The resulting rat's-nest of wire often had to be cut away to clear it, with serious waste of expensive wire.

The solution developed by Al Greenwood, former cable department supervisor in the plant, involved mounting a strip of aluminum at the back of each row of



Method of mounting aluminum strip on frame of spool rack

spools, in contact with the spool rims so wires cannot go over the rims. The aluminum is bent to exert slight pressure for braking, to stop overrunning of the spool when a long length of wire is pulled.

Adhesive Replaces Solder For Wattmeter Magnets

By Bernard Gould

Manager, Market Development
Rubber & Asbestos Corp.
Bloomfield, N. J.

A NEW SINGLE-COMPONENT epoxy adhesive is now being used in place of silver soldering or brazing by the Westinghouse Meter Division in Newark, N. J. for bonding two Alnico magnets to a silicone steel lamination stack in their type 44 recording wattmeter. The adhesive selected for this purpose is Bondmaster M620, made by Rubber & Asbestos Corp., Bloomfield, N. J.

Conventional bonding techniques for such an assembly would involve the use of silver solders whose application temperatures range in excess of 1,000 F. Drawbacks of such temperatures include the possibility of stack distortion due to dif-

DESCRIPTIVE DATA

- **SIZE:** 1 inch diameter x 2¼ inches long
- **WEIGHT:** 3.8 ozs.
- **FULL SCALE RANGE:** 40 to 400 degrees/second
- **LINEARITY:** 0.1% of full scale to ½ range, within 2% to full range
- **RESOLUTION:** 0.01% full scale
- **DAMPING:** Fluid damped, temperature compensated
- **PICKOFF:** Variable Reluctance type, 400 - 6,000 cps
- **MOTOR EXCITATION:** 6.3 volts - 400 cps, 26 volts - 400 cps, 9 volts - 1,000 cps

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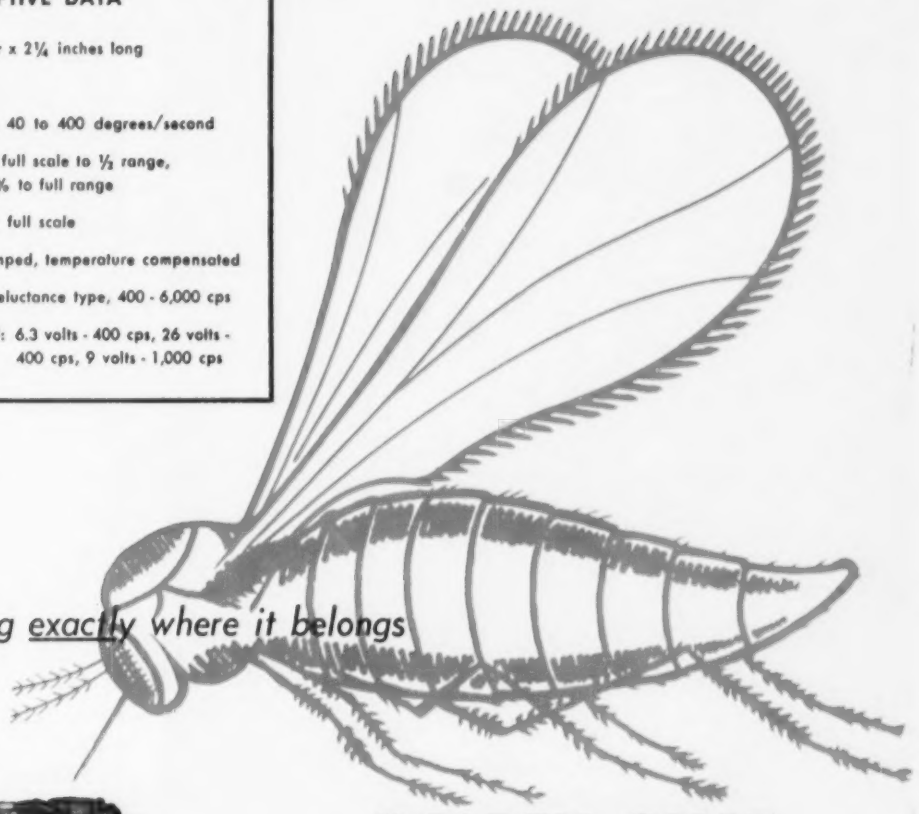

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BLILEY ELECTRIC COMPANY
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ERIE, PENNSYLVANIA

Bliley

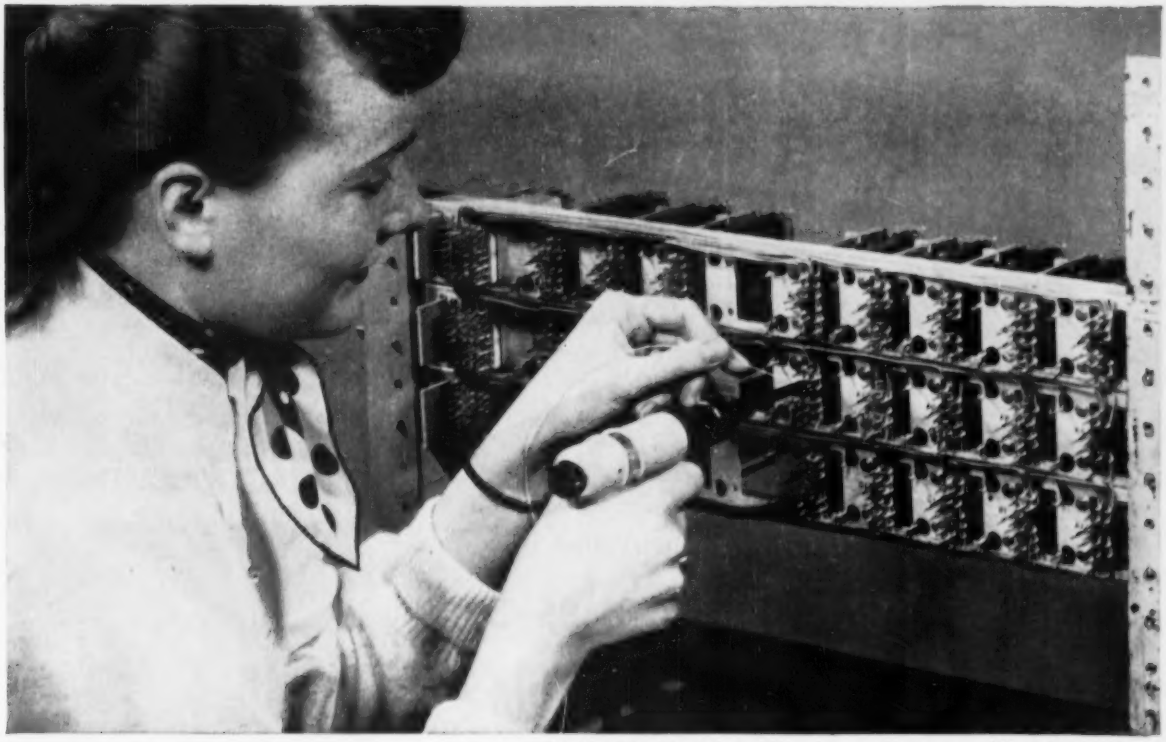
Rolling out Bondmaster M620 adhesive on palette just as it comes from can, to give uniform coating on application roller. Alnico magnets and lamination stack to be joined for Westinghouse recording wattmeter are shown in background

fering expansion coefficients of the two metals, the danger of changing magnetic qualities because of the heat and unrelieved mechanical strains, and possible entrapment of corrosive soldering flux in the joints.

▶ **Advantages of Adhesive**—The limitations and potential hazards of soldering or brazing temperatures can be eliminated substantially by the use of heat-curing epoxy adhesives with their relatively low bonding temperatures (260 F to approximately 535 F). The use of adhesives for metal bonding also makes it possible to simplify an entire phase of mass production by eliminating the critical application techniques demanded for truly efficient soldering operations.

Although two-component epoxy adhesives have long been used for

Applying cement to face of Alnico magnet



Keller "Wire-Wrap" tools play an important part in assembly of these well-known products: TV sets, computers, electric motors, radios.

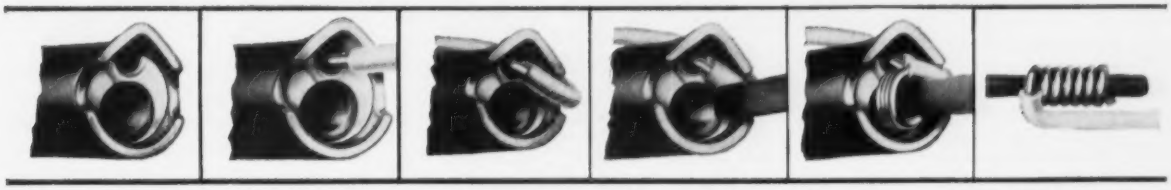
Why solderless connections with Keller "Wire-Wrap"® Tools are fast . . . reliable

Keller "Wire-Wrap" tool is fast operating—only seconds per connection. It automatically wraps wire around terminals to make solderless, permanent connections. No additional operations required. Tool weighs just one pound . . . no operator fatigue to slow down production schedules.

There are no faulty connections requiring expensive hand repair work. To date, well over 700 million connections have been made with "Wire-Wrap" tools without a reject. The exclusive controlled-tension compresses wire into terminal to assure permanent metal-to-metal contact. Either air or electric models.

Possibly you can step up production with "Wire-Wrap" tools while reducing assembly costs. Consult with your Gardner-Denver Industrial Specialist.

2.7 to 3 seconds to make a connection



Empty "Wire-Wrap" tool spindle | Insert wire in top opening | Anchor wire in side notch | Insert terminal in bottom opening | Apply power to wrap wire around terminal | Finished connection is permanent

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New 'Diamond H' Series S Relays Doubly Dependable

in dry circuits

Separately sealed coils isolated from completely inorganic switches within their hermetically sealed cases make these new "Diamond H" Series S aircraft type 4PDT relays supremely reliable in dry circuits.

Physically and electrically interchangeable with "Diamond H" Series R relays, widely used in guided missiles, computers, jet engine controls, automation control systems and similar critical applications because of their broad range of performance characteristics, Series S relays will permit intermixing of dry and wet circuits safely.

Contacts are specially processed and cleaned before assembly; subsequent contamination from gases off the coil insulation is prevented by the coil seal. The switch mechanism has been simplified and is completely inorganic to eliminate other possible causes of malfunctioning.

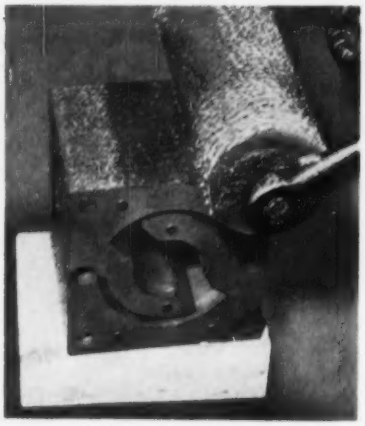
Standard contact ratings include 30 V., D. C.; 115 V., A. C.; 2, 5, 7-1/2 and 10 A., resistive; 2 and 5 A., inductive, with special ratings available to 350 V., D. C., 400 MA, or other combinations including very low voltages and amperages, or amperages up to 20 for short life requirements. Coils are available with resistances of 1 ohm to 50,000 ohms. Operating time of 24 V. models is 10 ms. or less; dropout less than 3 ms.

Vibration resistances range from 10-55 cycles at 1/16" double amplitude to 55-2,000 cycles at 20 "G"; operational shock resistances to 50 "G" plus, and mechanical shock resistance up to 1,000 "G". Nine standard mounting arrangements, plus a ceramic plug-in socket, are available. The unit displaces only 1.6 cubic inches, excluding terminals.

"Diamond H" engineers will be happy to work out a variation to meet your specific requirements. Tell us your needs . . . or write for bulletin on new "Diamond H" Series S relays.

THE HART MANUFACTURING COMPANY

202 Bartholomew Avenue, Hartford, Conn.



Applying cement to laminated core

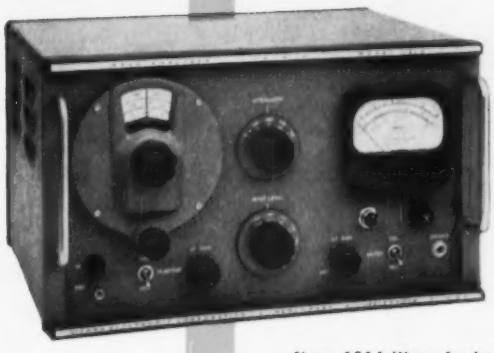
Assembling parts to be bonded in special jig. Thumbscrews on side and at far end provide all the contact pressure needed

bonding in the aircraft industry, the need for mixing components immediately before use was a serious drawback for mass production. The recent development of a single-component 100-percent solids epoxy adhesive overcame the physical difficulties involved. Although not as strong as the best available aircraft adhesives in peel strength and in its ability to withstand continuous service at high heat, the new adhesive development offers an excellent balance of good strength properties which appear to be more than sufficient for conventional metal-working use.

The new one-part epoxy paste adhesives can be applied right from the shipping container as an easily-spread paste, about the

Fast, convenient, dependable

precision wave analyzers frequency-selective voltmeters



Sierra 121A Wave Analyzer

Sierra now offers exactly the instruments you need for wave analysis, wire carrier and microwave subcarrier applications.

Sierra 121A Wave Analyzer is a highly selective, double superheterodyne receiver covering frequencies from 15 KC to 500 KC and providing wave analysis data directly in voltage and dbm at 600 ohms. The instrument offers the selectivity required for use with new single sideband carrier systems.

Sierra 158A Wave Analyzer is similar but covers frequencies from 500 KC to 10 MC.

Both analyzers have high selectivity, accuracy of ± 2 db, spurious response at least 50 db down, and a signal measurement range of 77.5 μv to 97.5 volts. The instruments are supplied in cabinet mountings which are readily adaptable to relay rack mounting.

SPECIFICATIONS — SIERRA VOLTMETERS

Model	Frequency Range—kc	Selectivity		Accuracy		Direct Reading in dbm	
		Down 3db	Down 45db	Frequency	Measuring	Balanced	Unbalanced
101C	20-500	± 550 cps	± 2900 cps	Note A	± 3 db	Note D	600 ohms
103B†	3- 40	± 400 cps	± 3000 cps	± 0.5 kc	± 3 db	Note D	600 ohms
104A	5-150	± 300 cps	± 1500 cps	± 1 kc	± 3 db	Note D	600 ohms
108B	15-500	± 550 cps	± 2900 cps	± 3 kc Note B	± 2 db Note C	135 ohms Note D	600 ohms
114A	100-800	± 550 cps	± 2900 cps	Note A	± 3 db	Note D	600 ohms

All Sierra Carrier Frequency Voltmeters feature built-in calibration oscillators and circuits for level calibration, have aural monitoring jacks, and (except 103B) are furnished with Sierra Model 149A Precision Spiral Scale Dials.

† Contains carrier re-insertion oscillator for monitoring suppressed carrier systems. Furnished with planetary drive dial. Note A. Ranges from ± 2 KC at low end of dial to ± 3 KC at upper end. Note B. ± 1 KC in the 48 KC to 256 KC region. Note C. ± 1 db for + 30 db to — 40 db attenuator steps on 135 ohm balanced measurements. Note D. All models may be converted for 135 and 600 ohm balanced line measurements by convenient plug-in bridging transformer, Model 130D.

Sierra 101C Carrier Frequency Voltmeter

For carrier system and other field or laboratory work between 5 kc and 800 kc, Sierra offers 5 accurate, stable, tuned vacuum tube voltmeters. All are direct reading in voltage and dbm at 600 ohms from —80 dbm to +42 dbm.

Line Bridging Transformer

Model 130D Dual Impedance Line Bridging Transformer converts VTVM and wave analyzer inputs from single-ended to balanced operation. Covers 5 kc to 500 kc, bridges both 135 and 600 ohm balanced lines.

Impedance Meter, Line Fault Analyzer

Sierra 166 Impedance Meter (at left) measures impedance on high noise circuits, 30 kc to 300 kc; measures on "hot" lines through coupling capacitor. *Sierra 124 Line Fault Analyzer* pinpoints shorts, opens or grounds on open wire lines. Direct reading, range ½ to 200 miles, accuracy ¼ mile.

Data subject to change without notice.

sierra

Sierra Electronic Corporation

A Subsidiary of Philco Corporation

3885 Bohannon Drive DAvenport 6-2060 Menlo Park, California, U.S.A.

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consistency of moderately firm cold cream. It may be spread by spatula, brush or even by roller squeegee.

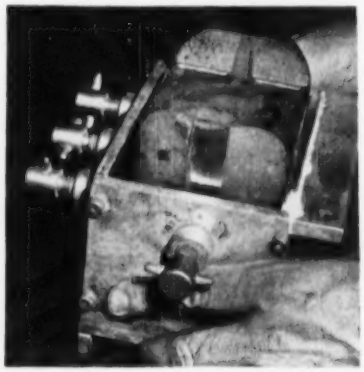
► **Curing**—A wide range of possible curing cycles is available, depending upon a maximum temperature which may be tolerated or available for making the assembly or, conversely, upon the required speed of application if curing time is a limiting factor in production. Alternative cure cycles are:

Temperature in Bonding Layer	Minimum Curing Time
535 F	7 to 10 minutes
500 F	12 to 15 minutes
450 F	20 to 25 minutes
400 F	40 to 50 minutes
350 F	1½ to 2 hours
300 F	4 to 5 hours
260 F	20 to 24 hours

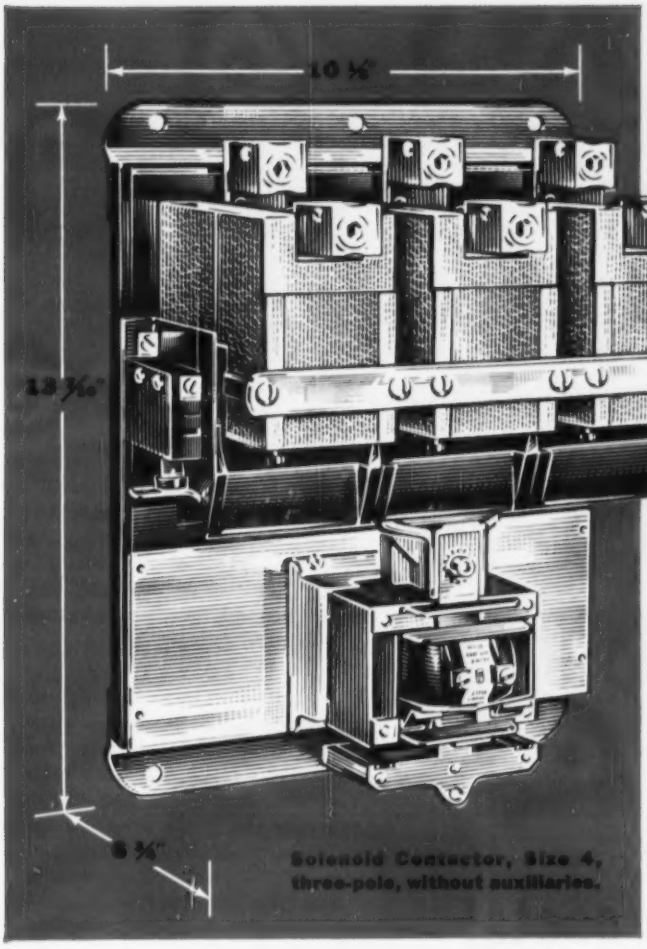
Only low contact pressures, on the order of 5 to 15 psi, are required.

Once applied, the adhesive does not flow or drip during the curing cycle. Thus, normal post-cleaning operations involved in soldering, brazing and conventional cementing, are completely eliminated. The new material will not drip or run regardless of the curing cycle used. This unique thixotropic characteristic makes this type of paste adhesive particularly effective for poor-fit and similar void-filling applications.

► **Cost Factors**—Silver solders, as an average, currently sell within a range of $11 to $18 per pound. As opposed to this, M620 in pro-



Placing jig in oven for curing bond



Solenoid Contactor, Size 4, three-pole, without auxiliaries.

NEW 150-amp solenoid contactor extends proven line

This new Size 4 A.C. solenoid contactor is ideal for use in motor starters and controllers for main line, accelerating and reversing purposes and for resistance heating and lamp loads as well.

It's the new Bulletin 4454—incorporating many advanced design features found on Ward Leonard's Sizes 0 to 3 contactors. Check these outstanding features:

New sintered-silver-cadmium-oxide contacts—can repeatedly handle high inrush currents without a sign of contact welding, excessive pitting or other damage.

Simple, compact solenoid design—excellent for modern metal control panels using accessible front-of-board wiring, particularly useful where panel space is limited.

Available with two or three main poles and up to 4 side-mounted auxiliaries. Also with provision for mechanical interlocking and addition of overload relays.

Completely described in Bulletin 4454. Write for your copy today. The Ward Leonard Electric Co., 30 South Street, Mount Vernon, New York. (In Canada: Ward Leonard of Canada Ltd., Toronto.) 7-6

ENGINEERING DATA

Size 4 A.C. Contactor Ratings*

Service	8-Hour Ampere Rating		Enclosed Power Rating	
	Open	Enclosed	Three Phase Volts	H.P.
Across-the-Line Starting	150	135	110 220 440-550	25 50 100
Across-the-Line Plug-Stop or Jogging	150	135	110 220 440-550	15 30 60

Service	8-Hour Ampere Rating	Single Phase Volts	K.W.	Three Phase Volts	K.W.
Resistive Heating Load**	150	110 220 440 550	15 30 60 75	110 220 440 550	26 52 105 130
Tungsten Lamp Lighting or Infrared Heating Load**	120 Amperes for 250 Volt Circuits or Less				

*The ratings listed are those recommended by the National Electrical Manufacturers Association.
**These ratings apply to open or enclosed contactors.

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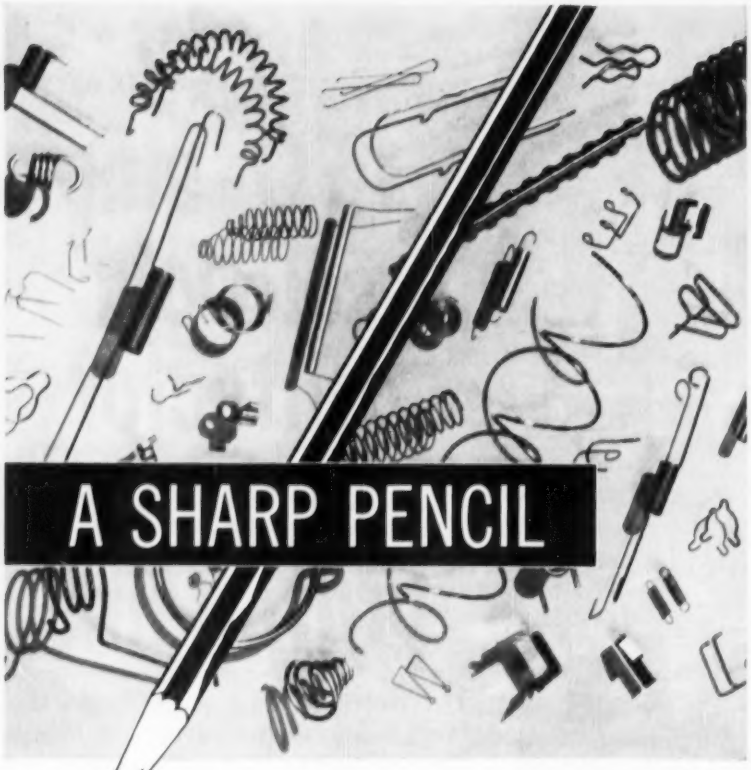

isn't the only way

to cut your Spring costs!

To concentrate on whittling pennies from a quotation sometimes may be a money-saving effort. But when it comes to buying springs it can be a costly practice, too.

A quoted price means little if basic cost factors haven't been fully explored. For instance:

Is the spring designed most efficiently for the job, in its simple form, without unnecessary multiple operations?

Have exact and complete specifications been available as a quotation basis?

Were delivery requirements and production schedules taken into account?

Were production-line and assembly details considered from the point of spring packing and shop handling?

Was the design and production experience of the spring supplier used to save time, costs and headaches?

If all the above basic factors weren't considered in reducing spring costs to a minimum — you can't save money *even with a sharp pencil.*

Lewis offers you these services . . . and to help you solve a new product problem, will prepare machine-made samples for you, working closely with your design, engineering and production staff.

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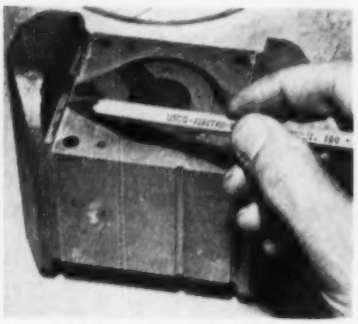
2656 W. North Avenue, Chicago 47, Illinois

Lewis PRECISION SPRINGS

The finest light springs and wireforms of every type and material



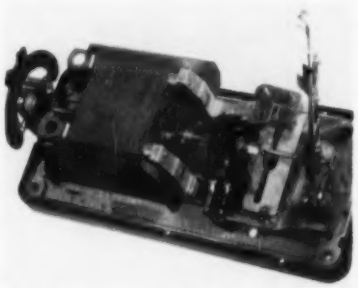
Pencil points to extremely fine glue line achieved in finished assembly

duction quantities is priced as less than $2.00 per pound at present. Additional savings accrue for greater uniformity in all aspects of application, along with ultimate production simplification.

▶ **Procedure**—The adhesive is first rolled out on a palette to enable the operator to obtain a uniform coating on his application roller. The adhesive is transferred by applying the roller over the magnet face, then over the laminated core.

The next step involves the mating of the parts to be bonded in a specially designed jig. Tightening of thumb screws holds the sections in position during heat cure. No pressure beyond mere contact and positioning pressure is required to effect the bond, so the need for costly pressurizing equipment is avoided.

The simple jig is placed in any standard oven for curing at any of the standard cycles. The jig is then removed from the oven



Completed wattmeter movement employing epoxy adhesive bonds in magnetic system

Now a standard line

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VARIABLE TRANSFORMERS for HIGH FREQUENCY APPLICATIONS

HS SERIES

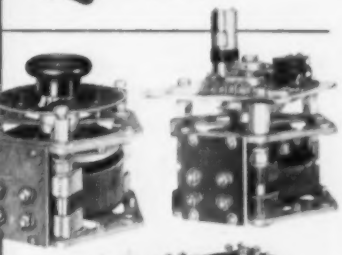
— ⅓ the weight — ½ the size of 60 cycle units

Designed for use in high frequency control systems where weight and space must be minimized, these POWERSTATS are ideal for ship, aircraft, guided missile and other 400/800 cycle applications.

Listed are some of the standard line of POWERSTATS for high frequency applications. However, many high frequency requirements necessitate designing to individual needs. The Superior Electric Company will be pleased to work with you on the design of POWERSTATS to satisfy new or unusual needs.

HM SERIES

INPUT		OUTPUT				MANUALLY-OPERATED MODELS				MOTOR-DRIVEN MODELS				
VOLTS	FREQUENCY CYCLES PER SECOND	VOLTS	MAXIMUM AMPERES	MAXIMUM KVA	TYPE OF CONSTRUCTION	TYPE	METHOD OF TURNING	APPROX. WEIGHT (POUNDS) NET	APPROX. WEIGHT (POUNDS) SHIPPING	TYPE	STANDARD MOTOR DRIVES	SPEED OF TRAVEL IN SECONDS	APPROX. WEIGHT (POUNDS) NET	APPROX. WEIGHT (POUNDS) SHIPPING
SINGLE PHASE														
28	400/800	0–28	2.0	.056	Open	3HMS02UK	Knob	0.5	0.9					
28	400/800	0–28	4.0	.112	Open	3HMS04UK	Knob	0.8	1.2					
120	400/800	0–120 or 0–140	1.0	.14	Open	1HMS01UK	Knob	0.9	1.3					
120	400/800	0–28	2.6	.073	Open	1RMS03UK	Knob	0.6	1.0					
120	400/800	0–120 or 0–140	3.0	.42	Open Square Frame	1HMS03UK	Knob	2.4	2.8	DM1HMS03U	28 Volt D-C	60	4.5	5.1
										AM1HMS03U	120 Volt A-C, 400 Cycles	60	4.5	5.1
120	400/800	0–120 or 0–140	7.5	1.0	Open Square Frame	1HMS07UK	Knob	3.4	3.8	DM1HMS07U	28 Volt D-C	60	5.5	6.1
										AM1HMS07U	120 Volt A-C, 400 Cycles	60	5.5	6.1
120	400/800	0–120 or 0–140	15.0	2.1	Open	1HL15UK	Knob	11.4	14.0	DM1HL15U	28 Volt D-C	60	13.2	16.2
										AM1HL15U	120 Volt A-C, 400 Cycles	60	13.2	16.2
240	400/800	0–240 or 0–280	3.0	.84	Open Square Frame	2HMS03UK	Knob	3.4	3.8	DM2HMS03U	28 Volt D-C	60	5.5	6.1
										AM2HMS03U	120 Volt A-C, 400 Cycles	60	5.5	6.1
240	400/800	0–240 or 0–280	9.0	2.5	Open	2HL09UK	Knob	12.8	15.4	DM2HL09U	28 Volt D-C	60	14.6	17.6
										AM2HL09U	120 Volt A-C, 400 Cycles	60	14.6	17.6
THREE PHASE														
240	400/800	0–240 or 0–280	3.0	1.5	Open	2HMS03UK-3Y	Knob	7.6	8.5	DM2HMS03U-3Y	28 Volt D-C	60	9.3	10.5
										AM2HMS03U-3Y	120 Volt A-C, 400 Cycles	60	9.3	10.5
240	400/800	0–240 or 0–280	7.5	3.6	Open	2HMS07UK-3Y	Knob	10.6	11.6	DM2HMS07U-3Y	28 Volt D-C	60	12.3	13.6
										AM2HMS07U-3Y	120 Volt A-C, 400 Cycles	60	12.3	13.6
240	400/800	0–240 or 0–280	15.0	7.3	Open	2HL15UK-3Y	Knob	34.5	41.0	DM2HL15U-3Y	28 Volt D-C	60	38.0	45.0
										AM2HL15U-3Y	120 Volt A-C, 400 Cycles	60	38.0	45.0
480	400/800	0–480 or 0–560	3.0	2.9	Open	4HMS03UK-3Y	Knob	10.6	11.6	DM4HMS03U-3Y	28 Volt D-C	60	12.3	13.6
										AM4HMS03U-3Y	120 Volt A-C, 400 Cycles	60	12.3	13.6
480	400/800	0–480 or 0–560	9.0	8.7	Open	4HL09UK-3Y	Knob	39.0	45.5	DM4HL09U-3Y	28 Volt D-C	60	42.5	49.5
										AM4HL09U-3Y	120 Volt A-C, 400 Cycles	60	42.5	49.5



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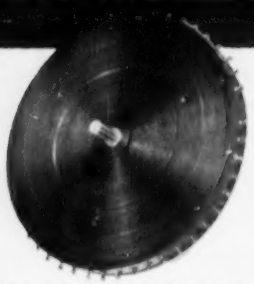
BIG PLUS in PRECISION POTS

RL-270A-1½ Precision Potentiometer . . . one of five sizes from 1¼" to 5" diameter. Nonmetallic housing has high dimensional stability, withstands −70F to +300F.

RL-270B-2 shows ganging which is available on all RL-270B models. Gamewell design requires only ⅜" per section, and external clamps provide unlimited phasing.

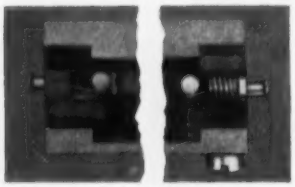
Gamewell *Blue Line* RL-270 A&B SERIES

RL-270A-5 is the largest in the *Blue Line* series. As with others, it is usually supplied with 3-hole mounting. Servo and threaded-bushing type mountings are available. Also many special features . . . send us your requirements.

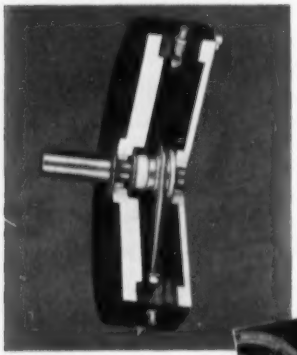


Special RL-270A-5 with 48 taps, shows maximum number. Allows 47 equal resistance sections, while maintaining guaranteed linearity of ±0.1%. Total resistance of 500,000 ohms, resolution of 0.0075%.

That Extra Margin of Reliability . . .



Exclusive Gamewell Terminal, Tap and Wiper Design



RL-270A and B Series available in many special variations. Write for catalog and specifications and prices on your specific requirements.

RL-270A Blue Line series offers these exclusive advantages:

- Proven and guaranteed linearity affords extreme accuracy, ±0.1 is best standard available.
- Terminal and Tap Design* uses positive precious-metal spring contacts with unit pressure over 10,000 psi. Assures permanent low-resistance contact without linearity distortion at taps.
- Shaft and Wiper Assembly* uses contoured slip-ring surface plated with noble metal, operating with noble metal brushes. Has excellent insulation to ground, high temperature resistance and zero moisture absorption.

THE GAMEWELL COMPANY
Newton Upper Falls 64, Mass.

GAMEWELL®

PRECISION POTENTIOMETER DIVISION

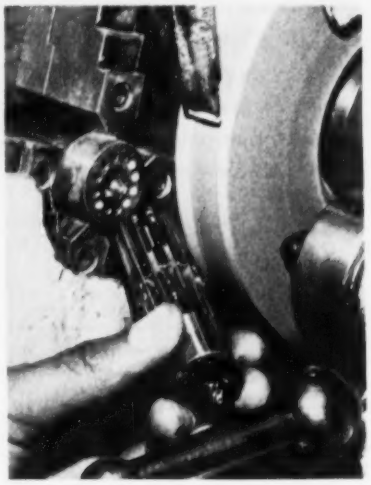
GAF 7

*Pat. applied for

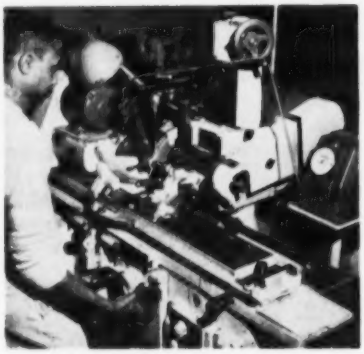
and allowed to cool. The finished assembly has an extremely fine glue line. The thickness of this glue line was predetermined at the time the adhesive was rolled onto the components to be asembled, since the adhesive is thixotropic and does not flow during cure.

Grinding Servo Stators

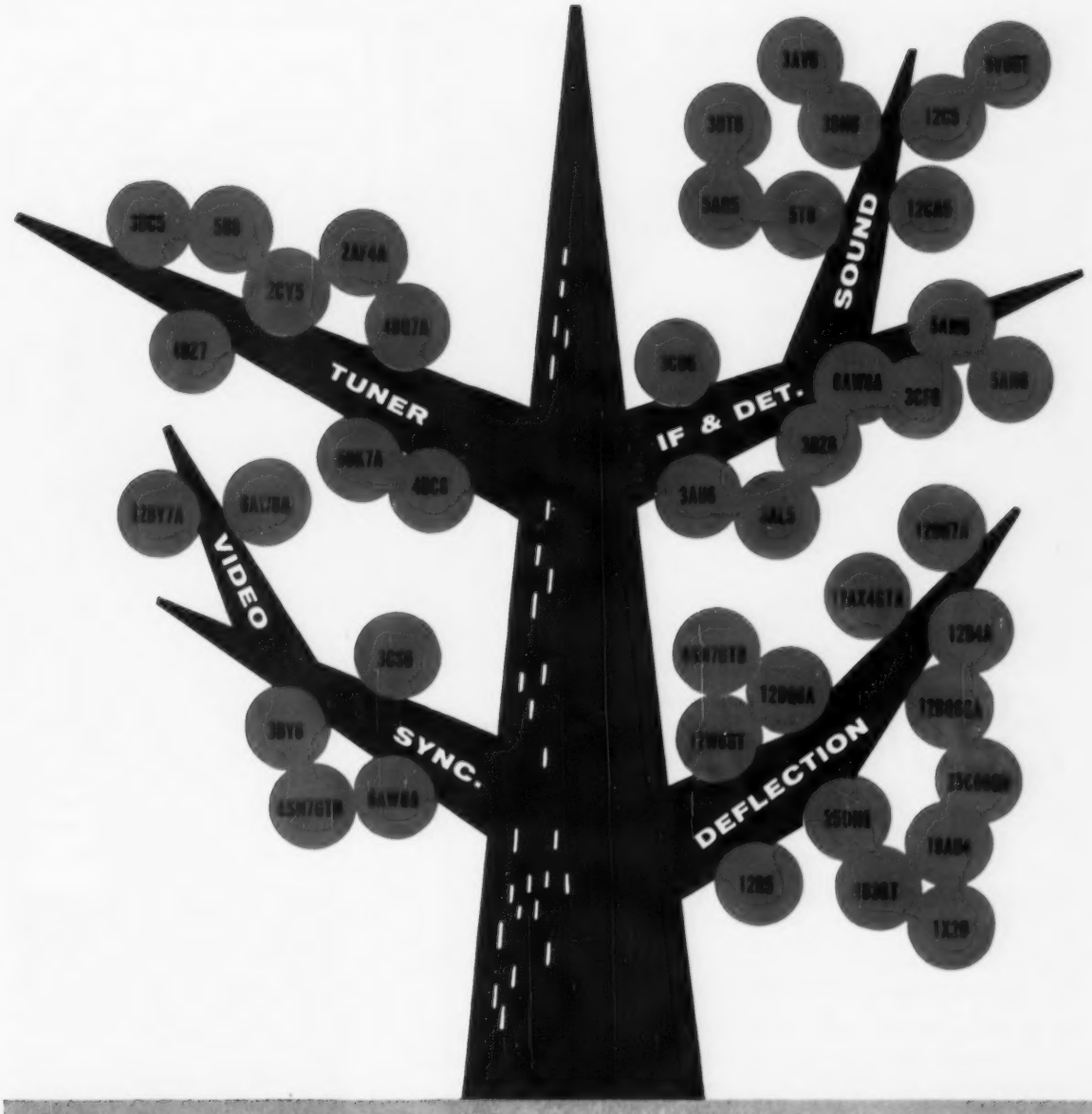
PLUNGE GRINDING of assembled stator stacks for servo motors is monitored automatically by an Arnold grinding caliper coupled with a Federal Dimensionair gage



Assembled stator on 16-pin fixture is inserted in mating holes of fixture located in headstock chuck and held by spring-loaded tail stock



Operator brings grinder up to work with right hand while watching pointer of air gage which indicates outside diameter. Adjustable strips of black tape on dial window show tolerance range. Flexible air line runs from gage to air leak valve at overhead pivot of caliper arm which rides against stator



The first family of 600 ma Series-String TV Tubes

In 1953, Tung-Sol became the leading proponent of 600 ma series heater tubes for TV receivers. This program was made possible through advanced designs in heater and cathode structures that would permit controlled heater warm-up time.

The success of this pioneering led further to the development of series-string tubes for 450 and 300 ma currents. These are designed for sets using smaller numbers of tubes.

In all, nearly one hundred of these types have been introduced, indicating the complete success of the series-string design principle.

Tung-Sol is currently supplying all of the series-string tube types required for replacement service as well as for initial equipment production.

TUNG-SOL®
ELECTRON TUBES

TUNG-SOL ELECTRIC INC., NEWARK 4, N. J.

BOURNS TRIMPOT®
MODEL 230 HUMIDITY-PROOF

Guaranteed to meet MIL Specs

This completely sealed TRIMPOT is manufactured and tested to meet Military Humidity Specification MIL-E-5272A (10 days).

Model 230 features a power rating of 0.4 watt at 50°C and a maximum operating temperature of 135°C. It is available from stock in standard resistance values from 10 ohms to 20,000 ohms.

In addition to reliable performance under severe humidity and salt spray conditions, this instrument will maintain accurate settings during extreme vibration, acceleration and shock encountered in aircraft and missiles.

Each TRIMPOT is individually inspected for compliance to guaranteed specifications, and is subjected to rigid quality control sampling tests to verify conformance to all specifications. 25-turn screwdriver adjustment, self-locking shaft, space-saving rectangular configuration and subminiature size are features also found in other Bourns TRIMPOT models. (Size: 3/16 x 3/8 x 1 11/32).

Send for catalog sheet 230.

BOURNS LABORATORIES, INC.
General Offices: 6135 Magnolia Ave., Riverside, Calif.
Plants: Riverside, California — Ames, Iowa

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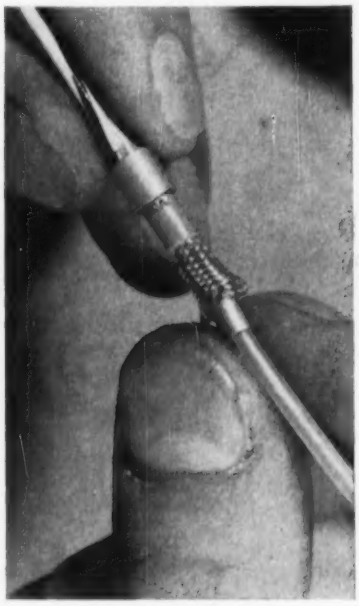
TRIMPOT • LINEAR MOTION POTENTIOMETERS • PRESSURE TRANSDUCERS AND ACCELEROMETERS

mounted on a Brown & Sharp No. 13 universal grinding machine in the Mechatrol Division plant of Servomechanisms, Inc. The gage frame bearing against the stator actuates a precision airprobe which controls the amount of air leakage in the gage system. The gage dial is calibrated to read directly to 0.00005 inch, so that the machine operator can grind to a precise outside diameter without stopping frequently to caliper the work manually.

Ferrule-Applying Tools For Shielded Wire

TWO SPECIAL TOOLS supplement a conventional crimping tool in the procedure used at Ford Instrument Co. for applying ferrules inside and outside the braided shielding of polystyrene-insulated wire.

As the first step, the blue-vinyl outer jacket is removed conventionally with a wire stripper. The outermost of the two ferrules is then pushed over the exposed shield and back over the remaining vinyl where it is temporarily



Pushing inner ferrule under shielding. Outer ferrule is temporarily over vinyl jacket, with two grounding wires under it. Grounds are made at the ferrules rather than at the connecting plugs

Boxed in?

Give your ideas (and yourself) a chance to develop...at Western Electric

Your career—to thrive—must be rooted in the good earth of opportunity. And few, if any, other companies offer this in the same degree as you'll find with us.

Give yourself this chance to grow . . . in a company that promotes from within. It's significant that of the 11,000 management positions we'll have ten years from now, 8,000 must be filled by newly promoted people.

Engineers at Western Electric participate in the planning and actions inherent in the broad management of the company. Here they become *more* than engineers since they acquire knowledge of production, handling of people, accounting, merchandising, etc. Fifty-five percent of the college graduates in our upper levels of management have engineering degrees.

Or look at the opportunity this way. Our job — in which engineers are key figures—is to make, distribute and install equipment needed by the Bell System. There's a constant need for new products, new processes, new facilities . . . new *ideas*. It's work that runs the gamut: electronic switching, printed circuits, miniaturization, automation, etc., (We're a natural incubator for automation since many of the things we make are needed by the millions.)

Besides our telephone job we've handled a continuous flow of defense contracts over the years . . . major projects like producing the Nike guided missile systems. Our joint telephone-defense job demands that young engineers and scientists develop as rapidly as possible. A full-time engineering education program is given new engineers during working hours to aid them to more easily assume a full engineering role in the company. Also, a tuition refund plan is provided for out-of-hours study at nearby colleges.

Check the career openings for which you may be qualified (mechanical, electrical, chemical and civil engineers; physicists and mathematicians). Send resume of education and experience to Engineering Personnel, Room **1066,** Western Electric Co., 195 Broadway, New York 7, N. Y.

Western Electric

MANUFACTURING AND SUPPLY UNIT OF THE BELL SYSTEM

Manufacturing plants in Chicago, Ill.; Kearny, N. J.; Baltimore, Md.; Indianapolis, Ind.; Allentown and Laureldale, Pa.; Burlington, Greensboro and Winston-Salem, N. C.; Buffalo, N. Y.; North Andover, Mass.; Lincoln and Omaha, Neb.; St. Paul and Duluth, Minn. Distributing Centers in 30 cities and Installation headquarters in 16 cities. Also, Teletype Corporation, Chicago 14, Illinois.

0 CPS to 1 MC!
DIRECT READING

new
Computer-Measurements Model 226A

UNIVERSAL COUNTER-TIMER

FREQUENCY • PERIOD • TIME INTERVAL • FREQUENCY

OUTSTANDING FEATURES:

★ Three independent, adjustable trigger level controls permitting full rated sensitivity at any voltage level between −300 and +300 volts.

★ Small voltage increments ordinarily masked by attenuators are easily selected.

★ Simplified color-coded controls and direct read-out in kc, mc, sec, or millisec, with automatic decimal point indication.

★ Oscilloscope marker signals facilitate start and stop trigger level adjustment for time interval measurement of complex waveforms.

A brand new, **multi-purpose** instrument provides precision measurement of frequency, frequency ratio, period (1/frequency) and time interval. Pressure, velocity, acceleration, displacement, flow, RPS, RPM, etc., may also be measured with suitable transducers. The 226A may be used as a secondary frequency standard.

price: **$1,100.00**

SPECIFICATIONS:

FREQUENCY MEASUREMENT

Frequency Range: 0-1,000,000 cycles per second
Input Sensitivity: 0.2 volt rms. Direct-coupled input
Time Bases: 0.00001, 0.0001, 0.001, 0.01, 0.1, 1 and 10 seconds. Also can use external 0-1 mc standard

PERIOD MEASUREMENT

Period Range: 10 microseconds to 1,000,000 seconds
Frequency Range: 0.000001 cps to 100 kc
Input Sensitivity: 0.2 volts rms. Direct-coupled input
Gate Times: 1 and 10 cycles of unknown frequency
Standard Frequency Counted: 1 mc; 100, 10, 1 kc; 100, 10, 1 cps; external 0-1 mc.

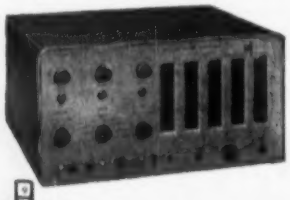
TIME INTERVAL MEASUREMENT

Range: 3 microseconds to 1,000,000 seconds
Start and Stop: Two independent or common channels Positive or negative slope
Input Sensitivity: 0.2 volts rms. Direct-coupled input
Standard Frequency Counted: 1 mc; 100, 10, 1 kc; 100, 10, 1 cps; external 0-1 mc.

GENERAL

Stability: Short Term: 1 part in 1,000,000 (temperature-regulated crystal)
Long Term: 3 parts per million per week
Display Time: Automatic: Continuously variable 0.1 to 10 seconds Manual: Until reset
Input Impedance: 1 megohm and 50 mmf
Trigger Level: Continuously adjustable from −300 to +300 volts
Accuracy: ± 1 count ± stability
Secondary Frequency Standard: 1 mc; 100, 10, 1 kc; 100, 10, and 1 cps
Dimensions: 17" W x 8¾" H x 13½" D approx.
Weight: 50 lbs. approx.

FREQUENCY • PERIOD • TIME INTERVAL • FREQUENCY



MODEL 225A 0 cps-100 kc
UNIVERSAL COUNTER-TIMER
Similar to the 226A in design. Featuring Oscilloscope Trigger Level Marker Signals; **Three Direct-Coupled Inputs of 70 mv sensitivity;** Direct Reading, Automatic Illuminated Decimal Point. Easily portable. **Price: $840.00**

CMC

Data Subject to Change Without Notice – Prices F.O.B. Factory

Write for complete specifications on the new 226A and the 225A models and the complete CMC line of electronic counting and controlling equipment.

Computer-Measurements Corporation
5528 Vineland Avenue, North Hollywood, Calif. 78E

ee-ee

out of the way. If additional leads are to be connected to the ferrule termination, their stripped ends are pushed under the outer ferrule at this time.

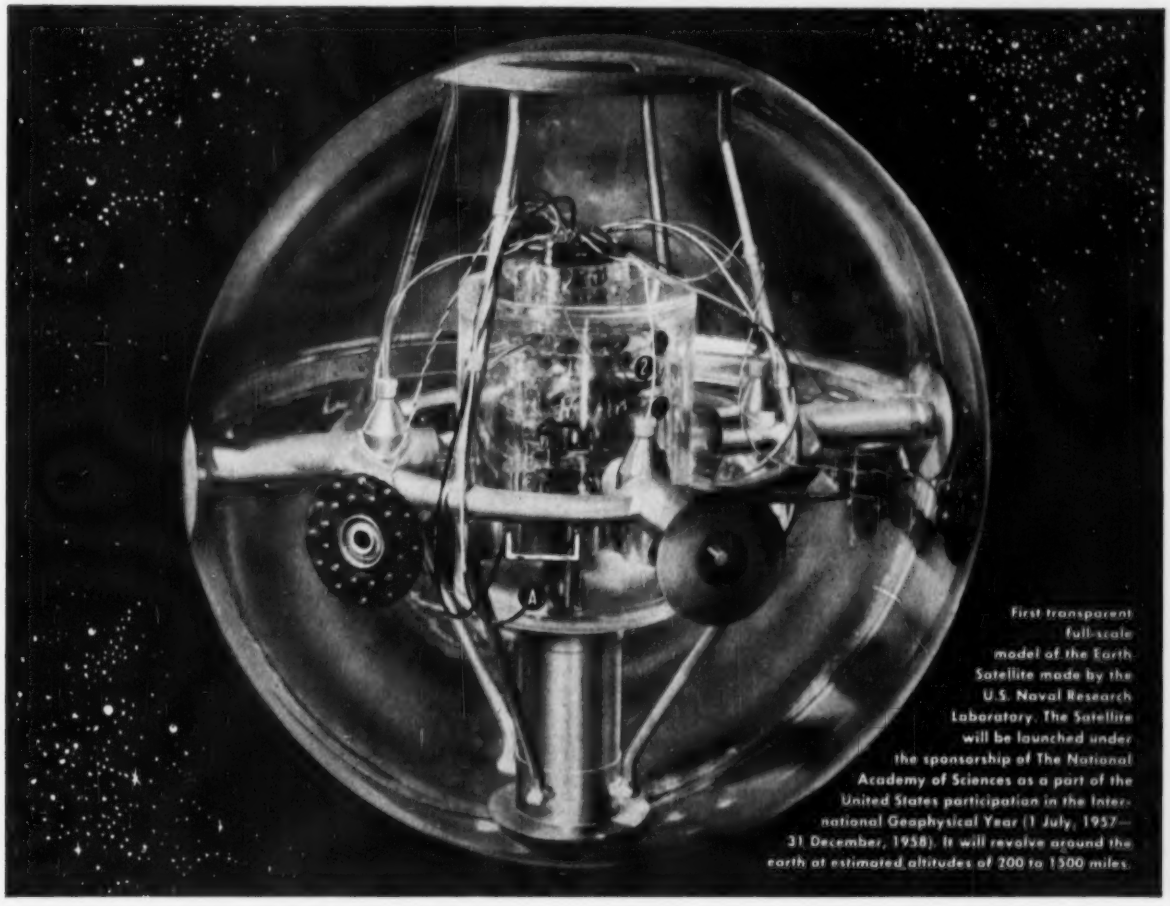
► **Installing Ferrules**—The shielding is pushed back with the fingers to spread it out, then cut away with scissors about ¼ inch from the blue-vinyl jacket. The inner ferrule is pushed over the polystyrene insulation and worked under the remaining exposed shielding as far as possible with the fingers.

On wires having a tight shielding weave, a tubular shield-spreading tool is slipped over the polystyrene and used to ream out the braid before pushing in the ferrule.

Telescoping ferrules together with modified pliers. In background is tubular tool used for reaming out shielding

Modified pliers are used to push the outer ferrule over the inner ferrule until the outer ferrule is just off the blue vinyl and is entirely over the shielding. Notches in the ends of the pliers correspond to the insulation diameters, so the wire projects through each notch when telescoping the ferrules. The inner ferrule is 3/32 inch longer than the outer, so projecting strands of shielding cannot pierce the polystyrene. A pin inserted in one plier jaw acts as a stop, insuring uniform application.

► **Finishing Operations**—The two



First transparent full-scale model of the Earth Satellite made by the U.S. Naval Research Laboratory. The Satellite will be launched under the sponsorship of The National Academy of Sciences as a part of the United States participation in the International Geophysical Year (1 July, 1957–31 December, 1958). It will revolve around the earth at estimated altitudes of 200 to 1500 miles.

How measure the impact of micro-meteorites on the first "Earth Satellite"?

When physicists at the U.S. Naval Research Laboratory consider an instrument or a material to record accurately the secrets of outer space—it's not size alone that counts, but dependable, reliable precision.

The strip of "Nichrome"* evaporated on glass ("A" in the photo above) which may be fitted to the outer skin of the Satellite, measures only ¼" wide x 1½" long. Its thickness: 100 Angstrom units (1/10,000 mm). Its function: to measure the surface erosion caused by the impact of micro-meteorites. The resistance of the Nichrome ribbon increases as the film becomes pitted by meteor particles.

"Nichrome is being considered for making this gage," states the Naval Research Laboratory, "because it supplies electrical resistance in a desirable range; adheres satisfactorily to glass in thin film form; and has a very low thermal coefficient of resistance."

There'll be no one on hand, 300 miles out in space, to check on or supervise the performance of the Nichrome strip. Nichrome needs no one. It will do its job dependably there—just as it will in *your* electronic or electrical equipment, after it is in your customers' hands.

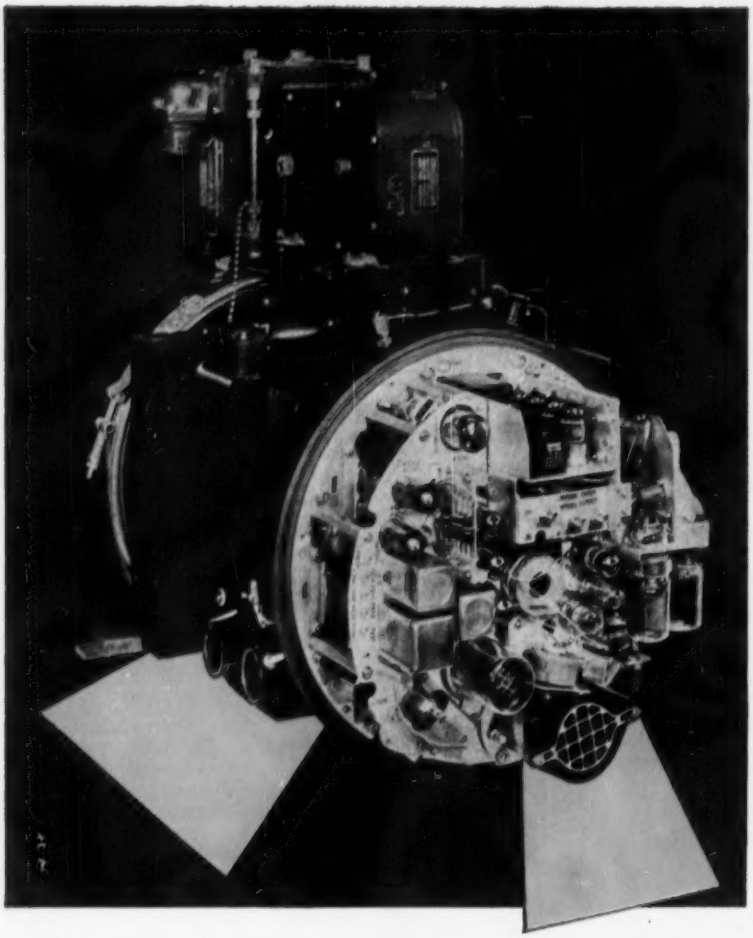
And remember, Nichrome is only one of the 132 special purpose alloys developed by Driver-Harris since 1899 for electrical heating, resistance, and electronic applications. Do you need a special alloy? Send us your specifications.

*T.M. Reg. U.S. Pat. Off.

Driver-Harris COMPANY HARRISON, NEW JERSEY

BRANCHES: Chicago, Detroit, Cleveland, Louisville, Los Angeles, San Francisco · In Canada: The B. GREENING WIRE COMPANY, Ltd., Hamilton, Ontario

MAKERS OF THE MOST COMPLETE LINE OF ELECTRIC HEATING, RESISTANCE, AND ELECTRONIC ALLOYS IN THE WORLD



Joy Fans HELP LICK HIGH VOLTAGE ARC-OVER IN AIR-BORNE RADAR UNIT

WHEN MOTOROLA designed this 10 inch air-borne radar indicator to operate at 60,000 ft. they eliminated high voltage arc-over by pressurizing the unit. But this created excessive heat.

TO DISSIPATE HEAT an air-to-air heat exchanger, using three Joy Axivane fans was built in. Two external fans blow outside air between two plates separated by aluminum tubing. Another Joy fan, sealed *inside* the pressurized radar unit circulates hot inside air thru this tubing.

THESE JOY FANS must operate in the wide temperature range of —55°C to +125°C . . . tough treatment.

Joy has over 250 models and 1300 designs of these high performance fans ready to solve your toughest air-moving problem . . . be it electronic cooling, de-icing and defogging or ventilation. Write *Joy Manufacturing Company, Oliver Building, Pittsburgh 22, Pa.* In Canada: *Joy Manufacturing Company (Canada) Limited, Galt, Ontario.*

Write for FREE Bulletin 143-39

WSW 1 6418-143

JOY . . . EQUIPMENT FOR AVIATION . . . FOR ALL INDUSTRY

Ground Power Units

Portable Lighting

Electrical Connectors

Vaneaxial Fans

Shearing exposed strands of shielding with modified end mill after crimping ferrules

Placing identifying sleeves on leads. Adhesive-faced cardboard in front of operator serves as tote tray for sleeves

ferrules are now crimped together with a standard hand-operated crimping tool. Projecting ends of shielding are then sheared off with a modified Pratt & Whitney eight-flute end mill. This is hollow so it can slip over the polystyrene and the inner ferrule, after which a fraction of a turn shears off the strands flush against the outer ferrule. Terminations of this type are used on a wiring harness for a U. S. Navy computer.

▶ **Identifying Leads**—After applying the ferrules, each termination is identified with its own numbered laminated vinyl sleeve. These sleeves are made by Duramark, Inc., Port Washington, N. Y., by printing the identifying numbers on white vinyl, then laminating with a transparent vinyl to protect

NEW Simpson

WIDE-VUE

panel instruments

4½"

3½"

2½"

a new concept

in styling and visibility

The clean, graceful lines of these "Wide-Vue" panel instruments add two plus values to your equipment. First, style—ultramodern beauty that blends with the advanced design of today's panels. Second, functionalism—longer scales together with wide-angle readability. The 2½" size, for example, has the same scale length as a conventional 3½" panel instrument. The durable, plastic cover is formed in one piece, and can be supplied with black or color finishes. Custom-built in 2½", 3½", and 4½" sizes. External magnet type movement or *self shielded* core magnet meter movement.

Simpson

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Phone: Estebrook 9-1121

In Canada: Bach-Simpson Ltd., London, Ontario

INSTRUMENTS THAT STAY ACCURATE

"Best Suited" for

HIGH TEMPERATURES

VARGLAS SILICONE

CLASS H

TUBING and SLEEVING

for applications requiring prolonged heat endurance at temperatures up to 260°C.

Varglas Silicone tubing and sleeving were developed by Varflex for applications involving continuous operating temperatures up to 260°C. Exceptional stability is combined with the following qualities . . .

FLEXIBILITY . . . sharp turns and 90° bends cause no cracking or peeling — no loss of dielectric strength.

DIELECTRICALLY-STRONG—All grades conform to NEMA and MIL-I-3190 standards.

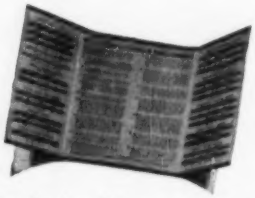
MOISTURE-RESISTANT—including resistance to salt water, mild alkalis and acids.

FLAME-RESISTANT — Standard burning test is 45 seconds to burn 1 inch. Can be made self-extinguishing on special order.

COLD-RESISTANT—Excellent resistance to chafing and abrasion, flexible to −35°C.*

**For temperatures down to −65°C, and for applications requiring extraordinary flexibility, we recommend our new Varglas Silicone Rubber sleeving and tubing. Inquiries invited.*

Send for FREE SAMPLES



Mail coupon today for free folder containing 25 different test samples of Varflex insulating sleeving, tubing, lead wire and tying cord.

Varflex CORPORATION
Makers of Electrical Insulating Tubing and Sleeving

VARFLEX SALES CO., INC., 308 N. Jay St., Rome, N.Y.
(For Silicone Products Only)

Please send me free folder containing samples of your electrical insulating tubing and sleeving.
I am particularly interested in insulation for _____

Name _____
Company _____
Street _____
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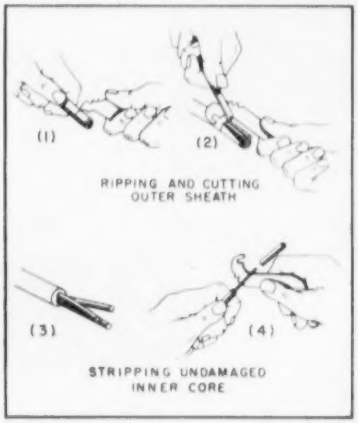
the marking. The sleeves are placed on corrugated cardboard covered with adhesive-up Scotch tape. All the sleeves needed for the job can thus be brought to a harness board without having them fall off or roll around, yet a required sleeve can easily be located and picked off for use.

Cable-Stripping Knife

THE AWKWARD JOB of ripping and stripping insulated sheaths of multiwire and single-conductor cables is greatly facilitated by using a special knife devised by Braun and Braun of Vienna, Austria, which eliminates danger of damaging the inner cores.

The curved knife has a main cutting blade, a hook-shaped cutting



Special stripping knife used for removing cable insulation

edge which ends in a blunt ball point and several separate notched blades at the opposite edge of the main blade.

To strip the outer insulation, the blunt point is forced into the outer sheath and the knife is pulled through parallel to the cable. This is repeated on the opposite side of the outer insulation. Both outer sheath ends are now pulled back and cut off with the main cutting blade. Since the hooked ripping end has no sharp edges at its extremity, the inner conductors are laid bare completely undamaged. The rear notched blades are then used to strip the insulation from the individual conductors.

Now...an accomplishment so far reaching it will change the sights of all rectifier users

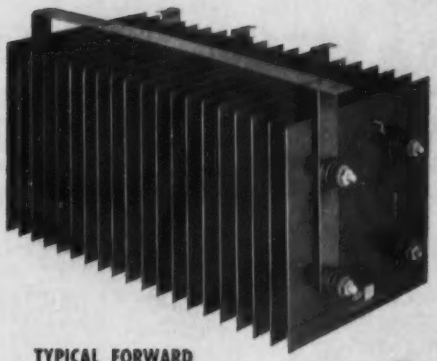
RADIO RECEPTOR'S improved new vacuum process

HCD* PETTI-SEL

**High Current Density*

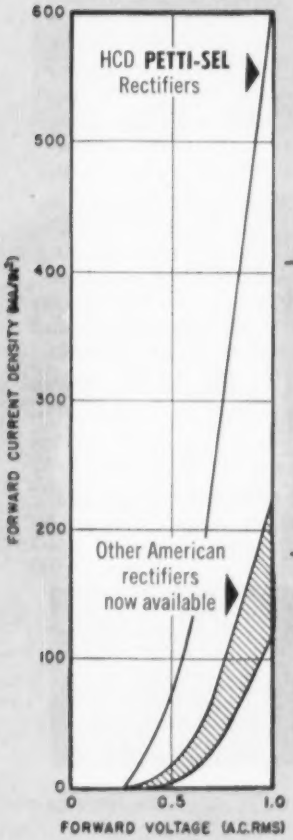
Industrial type SELENIUM RECTIFIERS

Developed by the famous Siemens Organization of West Germany and now manufactured by Radio Receptor Co. in the U. S. A.



- **Estimated life 100,000 hours**
- **Much smaller cell sizes than conventional units of the same ratings**
- **Lower forward voltage drop**
- **Suitable for high temperature applications**

TYPICAL FORWARD CHARACTERISTICS

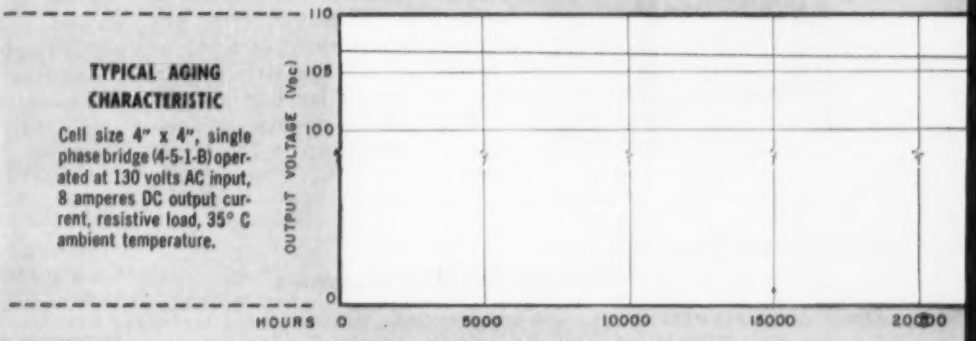


Far smaller in size than other rectifiers of the same current ratings, the new Radio Receptor HCD Petti-Sel units are manufactured under laboratory controlled conditions with fully automatic machinery, assuring new standards of product uniformity.

Field experience extending over several years with these rectifiers indicates an estimated life of 100,000 hours. This is largely attributable to the special process requiring no artificial barrier layer. Low forward voltage drop and low aging rate make the new Petti-Sel Rectifiers applicable to magnetic amplifiers and other control applications.

TYPICAL AGING CHARACTERISTIC

Cell size 4" x 4", single phase bridge (4-5-1-B) operated at 130 volts AC input, 8 amperes DC output current, resistive load, 35° C ambient temperature.



Watch for further announcements of unique developments on these history-making rectifiers. If you would like our new bulletin as soon as it is available, write today to Section E-5R.

Semiconductor Division

RADIO RECEPTOR COMPANY, INC.

Subsidiary of General Instrument Corporation

240 Wythe Avenue, Brooklyn 11, N. Y. • EVergreen 8-6000

Radio Receptor Products for Industry and Government: Selenium Rectifiers • Germanium Diodes Thermatron Dielectric Heating Generators & Presses • Communications, Radar & Navigation Equipment

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New Products

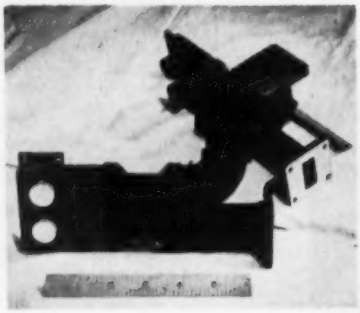
Edited by WILLIAM P. O'BRIEN

99 New Products and 60 Manufacturers' Bulletins Are Reviewed . . . Control, Testing and Measuring Equipment Described and Illustrated . . . Recent Tubes and Components Are Covered

BALANCED MIXER

operates over 7,800-8,200 mc

SAGE LABORATORIES, INC., 30 Guinan St., Waltham 54, Mass. This microwave mixer has been designed to operate over a frequency band from 7,800 to 8,200 mc in RG-51/U size (1¼ by ½ o-d) waveguide. As illustrated, the mixer is supplied with standard UG-51/U flanges and employs the new 1N23E type crystal diodes. The i-f outputs are solder lugs for this unit; however, these can readily be modified to any standard or special fitting. An input vswr of 1.25 to 1 can be assured; recent measurements indicate a vswr of 1.15 to 1 is obtainable.



Balanced mixers of this type can be designed and supplied in many waveguide sizes and frequency bands to solve the particular problem at hand. The unit can be provided in either brass or aluminum; crystals can be supplied in place with the unit. Further data available from company. **Circle P1 inside back cover.**

WIRE PROCESSER

an automatic machine

EUBANKS ENGINEERING CO., 260 N. Allen Ave., Pasadena, Calif., has announced a new automatic wire cutting and stripping machine with features designed to meet specific needs of the electronics industry.

The machine is designed to cut single-conductor, solid or stranded wire of from 32 ga to 12 ga in lengths of from 1 to 300 in. and to remove the insulation from one or both ends without scraping or cutting strands. The strip lengths may be varied from ¼ in. to 1 in.

Wire travels through the machine at speeds up to 150 ft per minute, with split-second stops for cutting and stripping. Production rates at top speed range from approximately 350 300-in. pieces per hr to more than 8,000 1-in. pieces per hr.

The machine is semiportable, can cut and strip tough insulation and can be synchronized with accessory equipment, such as a marking device or an induction heating unit for reflowing the tin on stranded wires before cutting and stripping.

Additional information about the model 810 machine is available. **Circle P2 inside back cover.**

ERECTOR SET CABINETS

to house electronic equipment

ELGIN METALFORMERS CORP., 630 Congdon Ave., Elgin, Ill. Industry now can select from 75 standard building-block components and 125 subparts to create consoles and cabinets to house equipment used in instrumentation, automation, automatic controls and electronics. Mass-produced modular units have been placed on the market.

Using the components and skeleton frames (foreground) results in the completed units (background): (1) At left, background, a universal equipment cabinet. (2) Second from left, background, the sloped front console, designed for reading instrumentation and

our leadership protects yours...

When you specify Cornell-Dubilier capacitors, you can be sure that nothing is left to chance. Production procedures, test and inspection operations and quality control are in full compliance with Cornell-Dubilier high-quality standards and *your* specifications. Quality and Reliability are talents we have cultivated since 1910. That's why you can count on the consistently dependable facilities of C-D's 16 plants!

Typical C-D paper tubulars:

TIGER CUB®: Cardboard-cased paper tubular with Polykane[1] end-fill. Vikane-impregnated for excellent capacitance stability. High moisture resistance. Operating temperature range: –55°C to +100°C.

TINY CHIEF®: Small, all-purpose paper tubular, molded in extra-hard thermosetting plastic for long-lasting all-around satisfaction. Available with high temperature wax impregnant for operating temperature range –40°C to +90°C and Vikane or Polykane® impregnant for –55°C to +100°C operation.

ROYAL CUB®: Cardboard-cased paper tubular with Polykane® end-fill. Tough, durable, withstands rough handling, vibration, shock, soldering iron heat. Operating temperature range: –55°C to +100°C.

BUDROC®: Steatite-cased paper tubular. Polykane® end-fill for extra protection against heat and humidity. High temperature wax impregnant for operating temp. range –40°C to +90°C and Vikane impregnant for –55°C to +100°C.

[1] Polykane: A development of the C-D laboratories. A solid thermosetting compound will not crack, soften or flow.

Write for catalog to Cornell-Dubilier Electric Corporation, South Plainfield, New Jersey.

CONSISTENT HI-DEPENDABILITY
CORNELL-DUBILIER CAPACITORS

SOUTH PLAINFIELD, N. J.; NEW BEDFORD, WORCESTER & CAMBRIDGE, MASS.; PROVIDENCE & HOPE VALLEY, R. I.; INDIANAPOLIS, IND.; SANFORD, FUQUAY SPRINGS & VARINA, N. C.; VENICE, CALIF.; & SUB.: THE RADIART CORP., CLEVELAND, OHIO; CORNELL-DUBILIER ELECTRIC INTERNATIONAL, N. Y.

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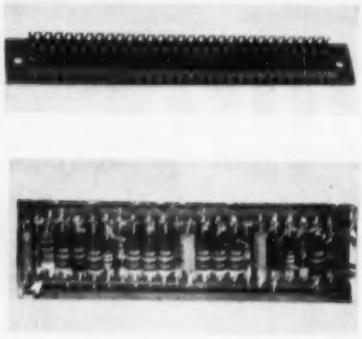
electronic controls. (3) Rack cabinet frame, background, shown with turret and writing top; this basic cabinet has a wide variety of uses for installation of equipment for automation and instrumentation. (4) The combination console, right background, which can be arranged from any number of varied basic units, is shown assembled in a side-to-side installation for a master central control station. Factory subassembled, the cabinets are merely bolted together with a Phillips-head screw driver, Tinnerman fasteners and screws, which are supplied with each cabinet.

One of the more elaborate consoles, factory subassembled from 30 component modules, sells for $600; a comparable custom-built model of the same type would cost over $1,500. The smallest EMCOR unit, a 13-in. instrument cabinet, sells for $24. **Circle P3 inside back cover.**

STRIP PACKAGE

for electronic components



ERIE RESISTOR CORP., Erie, Pa., has developed an electronic component packaging system which has been designed and tooled for production. It is engineered to provide ease of assembly and ease of servicing.

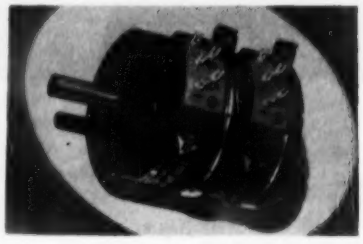
The process uses a phenolic board with automatically inserted continuous metal terminals. These terminal connections are automatically cut out in accordance with the required circuitry leaving connecting jumpers where needed. Crossover connections are made through the use of jumper wires on the face of the board or through the use of printed wiring on the back of the board when desired.

Components and lead-off wires are then easily inserted in the terminal strips, either automatically or manually without costly lead preparations. Spacing of the metal strips may be varied, depending on the required length of the components. **Circle P4 inside back cover.**

NONLINEAR POTS

in variety of sizes

ACE ELECTRONICS ASSOCIATES, INC., 103 Dover St., Somerville 44, Mass. A new line of nonlinear, precision wire-wound potentiometers in standard and subminiature sizes for sine-cosine and square-law functions is now available in prototype and production quantities.

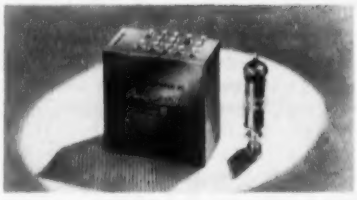


Standard sine-cosine Acepots are available in sizes 30 and 20 with tolerances of ±0.5 percent peak to peak and ±1.0 percent peak to peak respectively. Standard square-law Acepots are available in sizes 30 and 20 with tolerances of ±0.25-percent and ±0.75-percent independent conformity respectively. Nonlinear Acepots meet military specs. **Circle P5 inside back cover.**

CONTROL AMPLIFIER

diminutive, transistorized

PACKARD BELL ELECTRONICS CORP., 12333 W. Olympic Blvd., Los Angeles 64, Calif., announces a diminutive transistorized control amplifier that has become the vital element in regulating power for an entire military aircraft fire control system. Weighing but 11 oz the new control amplifier is expected to become a standard module adaptable to many and varied uses in electronics.



The custom component has a life expectancy of 10,000 hr or more, with ripple less than 50 mv from peak to peak, operating temperature of −65 C to +125 C and is adaptable to voltages of ±50 to ±1,000. Its regulation is ±1 percent, with circuit gain of 60 to 80 db. **Circle P6 inside back cover.**

RIBBON TYPE CABLES

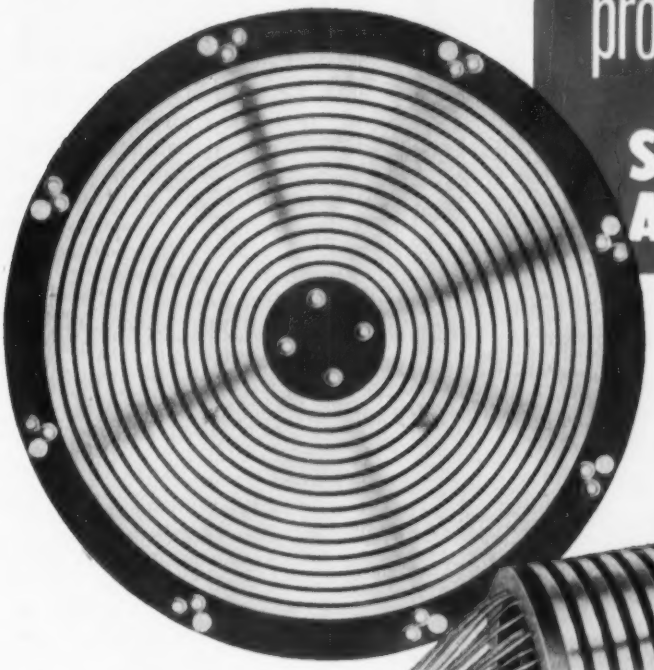
for missiles and aircraft

MILJAN, INC., a subsidiary of the Paul Omohundro Co., Paramount, Calif., has available three new

Now available the revolutionary ELECTRO TEC process* for your LARGE SLIP RING ASSEMBLIES

featuring

• LOWER COST • CLOSER TOLERANCES • ONE-PIECE CONSTRUCTION • JEWEL-LIKE FINISH • UNIFORM RING HARDNESS • REDUCED WEIGHT



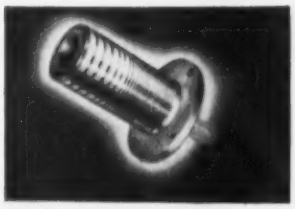
Now a Complete Service in all sizes of Slip Ring Assemblies

⇑ *An assembly with 14 concentric, hard silver rings electro deposited into machined plastic blank. Dovetail locks rings in place. Machined blank insures accuracy. Diameter approx. 11", thickness approx. 5/16".*

⇒ *An assembly with 30 rings of various widths to accommodate various current requirements. Unit is approx. 4-5/16" long, designed for flange mounting.*

⇒ *Cylinder type assembly approx. 3¼" long with 24 hard silver rings. 1⅝" O.D. with wall thickness less than ¼".*

⇒ *Cylindrical assembly with 25 rings. Three wide rings accommodate large contact area brushes for high current capacity. Length 14", O.D. approx. 5⅜".*



*PAT. NO. 2,696,570

ELECTRO TEC is now tooled up, with new expanded facilities for production of large Slip Ring Assemblies to exact customer specification. Sizes range up to 36" in diameter, either cylindrical or disc type.

The exclusive ELECTRO TEC PROCESS*—the electro-deposition of hard silver rings into an accurately machined plastic blank—consistently yields a high degree of dimensional accuracy, excellent concentricity, and a jewel-like ring finish. This process also eliminates expensive tooling and mold charges, frequently lowers costs to 30% of other methods of manufacture. The silver rings are uniformly hard for long life—70-95 Brinell.

ELECTRO TEC one-piece construction precludes dimensional variation due to accumulated errors. The plastic base is fully cured before rings are plated into it, thus preventing separation of base material from the rings.

ELECTRO TEC LARGE SLIP RING Assemblies are widely used in Radar Equipment, Fire Control Systems, Test Tables and many other critical applications. Light weight combined with rugged durability recommends their use in airborne applications.

Every user knows the ELECTRO TEC reputation for quality and superiority in miniature and sub-miniature slip ring assemblies.

Our Engineering Department is available for consultation on any of your slip ring problems without obligation.

ELECTRO TEC CORPORATION

SOUTH HACKENSACK • NEW JERSEY

Want more information? Use post card on last page.

For All Low Voltage Applications

DUAL RANGE TRANSISTORIZED REGULATED POWER SUPPLY

Model 50TM/10
Price $235.00
FOB, Nutley, N. J.

- Dual Range, Low Voltage Output
- Continuously Variable 0-Max.
- High Conversion Efficiency
- Low Heat Dissipation
- Instant Warm-Up Time
- Small Size, Light Weight
- Non-Microphonic
- Rugged, Long Life Design

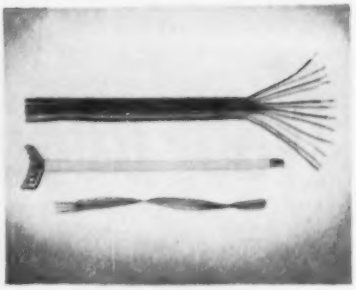
ERA's compact model 50TM/10 power supply is a semi-conductor, regulated transistorized, dual range design intended for all low voltage applications. Two convenient vernier voltage ranges are available 0-10 VDC and 5-50 VDC, which makes these units particularly applicable for battery substitution, transistor biasing, low voltage reference use, and similar laboratory and industrial applications.

SPECIFICATIONS

Input	105-125 VAC, 60 or 400 cps
DC Output	Range 1 — 0-10 VDC . . . Range 2 — 5-50 VDC
Current	0-150 ma
Ripple	Less than 0.02% or 5 milivolts, whichever is greater
Type of Regulator	Semi-conductor Transistor Type
Regulation (Input)	Less than ±0.5% Change in Output for 105-125 VAC Input
Regulation (Output)	Better than ±0.5% Change in Output for Load Change 10-100% or 0.1 ohm Internal DC Impedance whichever is greater.
Size (H x L x W)	3½ x 9⅜ x 9½ Inches
Metering	2½" Output Voltage Meter Automatic Range Switching For Each Voltage Range

ERA manufactures a variety of transistorized power supplies, miniaturized power packs and special purpose units. Write for details on standard and special models.

Electronic Research Associates, Inc.
67 East Centre Street, Nutley 10, N. J.
Nutley 2-5410

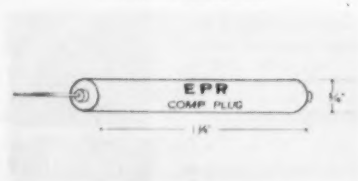


cable types for electronic systems of missiles and aircraft.

A Teflon encapsulated color coded flat cable provides the inertness of Teflon insulation in a transparent Teflon bonding that permits visual identification of separate wires at any point. Mil-Std 104 insulation colors are provided, with two and three-color striped insulation also available. Wire sizes range from 16 to 26 gage and cables may have any number of wires up to a maximum of 2 in. in width.

Etched circuit type conductors are molded in pliable silicone rubber with fanned wire terminations to make a second cable of great flexibility and minimum thickness, ranging down to 0.008 in. where voltage requirements are low.

A subminiature Teflon cable, identified as type TB, is the third item in this cable line. Wires of 1 mil diameter, or similar flat ribbon conductors, are imbedded in Teflon 0.008 in. thick. Type TB cables are made to design length for each customer, design length being limited to about 12 in. **Circle P7 inside back cover.**



PLUG-IN COMPONENT
packaged design

EASTERN PRECISION RESISTOR CORP., 675 Barbey St., Brooklyn 7, N. Y., has developed a plug-in component package (Comp-Plug), especially designed for use with the new AMP shielded patchcord programming system. These versatile com-

LVDT MEASUREMENTS...

SCHAEVITZ Linear Variable Differential Transformers produce a voltage proportional to linear displacement. These units are widely used in measurement of displacement or distance. Variables such as force, weight, pressure and acceleration that can be expressed in terms of displacement can also be measured. Shielded and unshielded units are available in miniature and conventional sizes.

ONLY SCHAEVITZ ENGINEERING HAS THE EXACT TYPE OF **LVDT** TO MEET YOUR REQUIREMENTS

schaevitz engineering

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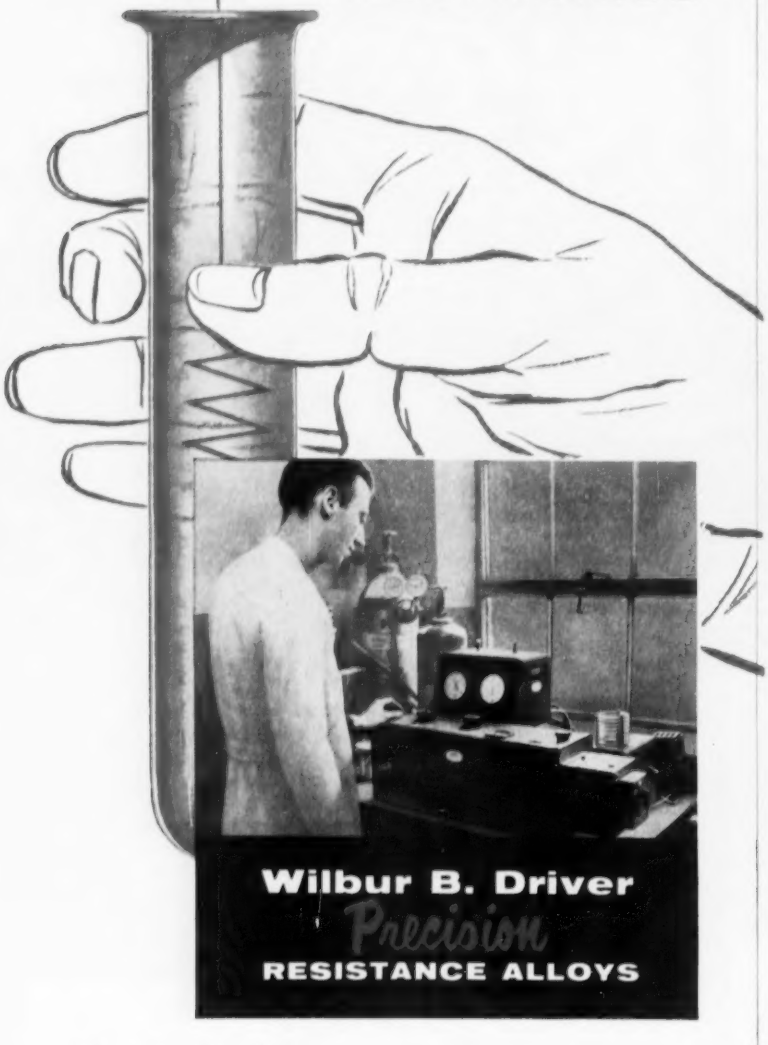
THE WBD CHEMIST —

A KEY MAN IN ELECTRONICS



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Precision
RESISTANCE ALLOYS

Progress Plus! Producing *precision* resistance alloys for electronics goes far beyond melting and drawing techniques. Of even greater importance is quantitative analysis of the metal. All Wilbur B. Driver resistance alloys are subjected to thorough analysis. Thirty-five years experience plus ultra-modern production and laboratory facilities, assure quality that exceeds specifications. Whenever you see the WBD label, you can look for *BETTER* PERFORMANCE!

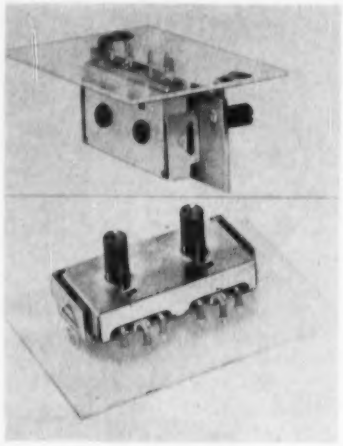
Wilbur B. Driver Co.
NEWARK 4, NEW JERSEY

For Over Thirty-five Years Manufacturers of Dependable Electrical, Electronic, Chemical and Mechanical Alloys

ponents can be used to patch an entire program into a computer, telemetering equipment or testing equipment.

The Comp-Plug (in this case a precision wire wound resistor) is encapsulated in a package measuring approximately ⅞ in. by 1 in. with one end terminated in an AMP male pin. The other end can be furnished as a solder terminal, a female receptacle or a cable to facilitate patching to other components on the board.

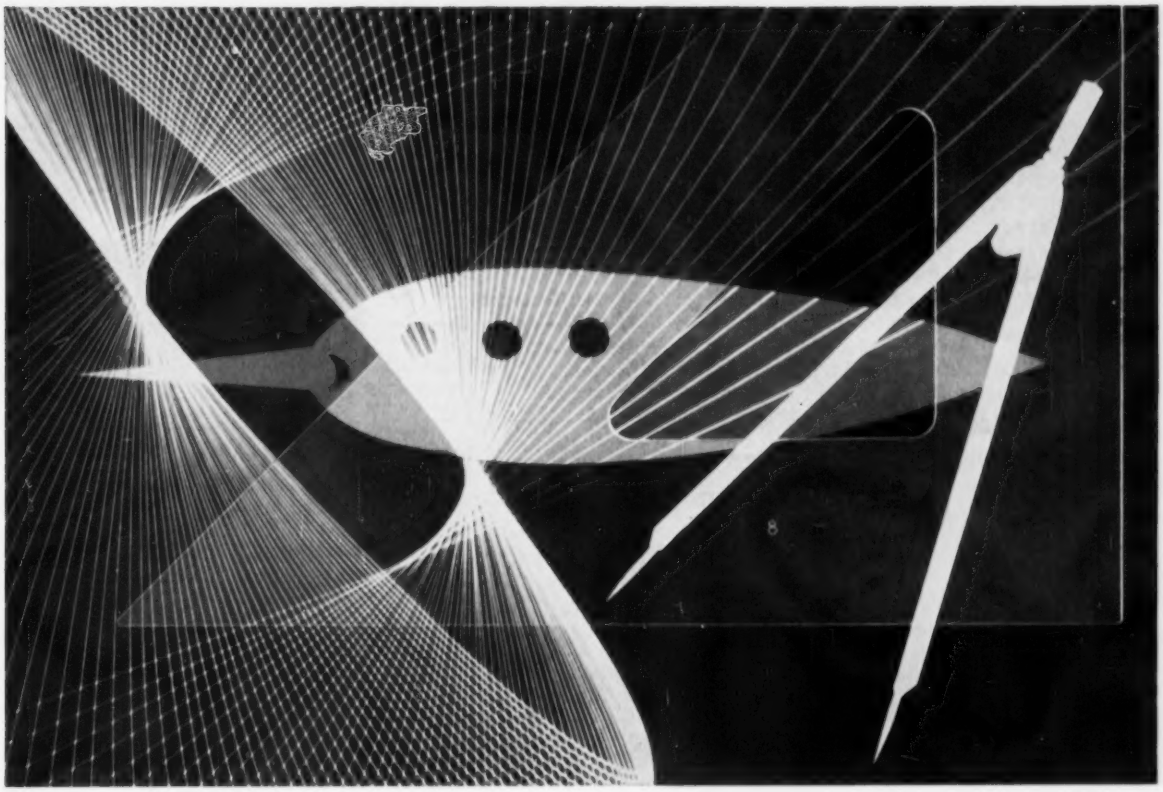
Diodes, capacitors, R-C networks are but a few of the components that can be supplied to specifications. Specific inquiries are invited. **Circle P8 inside back cover.**



VARIABLE RESISTOR
for tv printed circuits

CHICAGO TELEPHONE SUPPLY CORP., 1142 W. Beardsley Ave., Elkhart, Ind. Series U52 is a two-section side-by-side variable resistor which snaps instantly into place on printed circuit panels or on separate supporting brackets without need for mounting hardware or additional operations. It mounts parallel to the printed circuit panel with shafts perpendicular or can be mounted on separate supporting brackets with shafts parallel to the printed circuit board.

The control is quickly removed for servicing due to specially designed clip-off mounting supports and terminals. The ¼-in. diameter molded phenolic shafts for finger or screwdriver adjustment are



Creative Engineers:

Work where the breakthroughs are being made in every major field of Electro-Mechanics

As a creative engineer, you belong at the front-line of your field . . . where tomorrow's scientific battles are being won . . . where you can help win them.

For more than a decade, AUTONETICS has been at the forefront of electro-mechanical technology . . . building up the unique stockpile of experience and developing the advanced techniques and tools that can make your professional victories possible at AUTONETICS today.

Just a few specific results of AUTONETICS' pioneering are: the MG-4 Fire Control System for NATO's F-86K Sabre Jet; Flight Control elements for the F-100 Super Sabre; *Numill*, a new magnetic-tape controlled machine-tool system capable of performing complex milling and drilling operations automatically; *Recomp I*, a new portable, high-speed, completely transistorized digital computer; and inertial guidance systems for both airplanes and missiles.

Today, our programs are gathering speed, broadening scope. New engineering methods have been developed to cut lead time. System and component evaluation is being accelerated with automatic checkout equipment. Packaging is being designed and systems micro-minaturized to fit the cramped confines of sleek missiles and jets.

YOUR OPPORTUNITY EXISTS AT EVERY LEVEL of creative engineering from Preliminary to Performance Test—because Autonetics is one of the few companies in the world that can design and quantity-produce complete automatic control systems for both the military and industry.

LET US KNOW what kind of creative engineering interests you (please include highlights of your education and experience). Write today to: Mr. A. N. Benning, Administrative and Professional Personnel, Dpt. 358-EL-5, AUTONETICS, 9150 E. Imperial Highway, Downey, California.

Autonetics
A Division of North American Aviation, Inc.

AUTOMATIC CONTROLS MAN HAS NEVER BUILT BEFORE

Assistant Chief Engineer Norman F. Parker joined Autonetics in 1948 after receiving his DSc from the Carnegie Institute of Technology. Dr. Parker has been recognized nationally for his work in Inertial Navigation, and was chosen recently to present a paper on that subject at a NATO conference in Italy.

Jack Wittkopf was Associate Professor of Electrical Engineering at Oregon State for 6 years before he joined Autonetics in 1951. Now Group Leader in computers and electronics, Jack lives with his wife and four children in Autonetic's home town of Downey, California, where his spare time activities include photography and ham radio.

Standard types of COMMUNICATION EQUIPMENT

Radio Engineering Products is currently producing a number of types of equipment, electrically and mechanically interchangeable with standard Bell System apparatus. Complete equipments of the following types, and components for these equipments are available for early delivery.

CARRIER-TELEPHONE EQUIPMENT

C5 Carrier-Telephone Terminal (J68756). A kit for adding a fourth standard toll-grade channel to existing C systems is available.
C1 Carrier-Telephone Repeater (J68757)
121A C Carrier Line Filter and Balancing Panel
H Carrier Line Filter and Balancing Panel (X66217C)

CARRIER-TELEGRAPH EQUIPMENT

40C1 Carrier-Telegraph Channel Terminal (J70047C)
140A1 Carrier Supply (J70036A1, etc.)
40AC1 Carrier-Telegraph Terminal
Grid Emission Test Set (J70047D1)

VOICE-FREQUENCY EQUIPMENT

V1 Telephone Repeater (J68368F)
Power Supply (J68638A1)
V1 Amplifiers (J68635E2 and J68635A2)
V3 Amplifier (J68649A)
V-F Ringers (J68602, etc.)
Four Wire Terminating Set (J68625G1)
1C Volume Limiter (J68736C)

D-C TELEGRAPH EQUIPMENT

16B1 Telegraph Repeater (J70037B)
10E1 Telegraph Repeater (J70021A)
128B2 Teletypewriter Subscriber Set (J70027A)
Composite Sets, several types

TEST EQUIPMENT

2A Toll Test Unit (X63699A)
12B, 13A, 30A (J64030A), and 32A (J64032A) Transmission Measuring Sets
111A2 Relay Test Panel (J66118E)
118C2 Telegraph Transmission Measuring Set (J70069K)
163A2 Test Unit (J70045B)
163C1 Test Unit (J70045D)

COMPONENTS AND ACCESSORIES

255A and 209FG Polar Relays
Repeating Coils, several types
Retard Coils, several types
184, 185, 230A and 230B Jack Mountings

VACUUM TUBES

101D, F & L	323A & B	396A
102D, F & L	328A	398A
104D	329A	399B
205D	336A	400A
274A & B	350A & B	408A
281A	355A	120A Ballast Lamp
305A	393A	121A Ballast Lamp
310A & B	394A	

RADIO ENGINEERING PRODUCTS
1080 UNIVERSITY ST., MONTREAL 3, CANADA
TELEPHONE UNiversity 6-6887
CABLES RADENPRO MONTREAL

available in three styles. Resistance range is 250 ohms through 10 megohms and rotation angle 300 ± 5 deg.

R-F SOURCES
feature high output

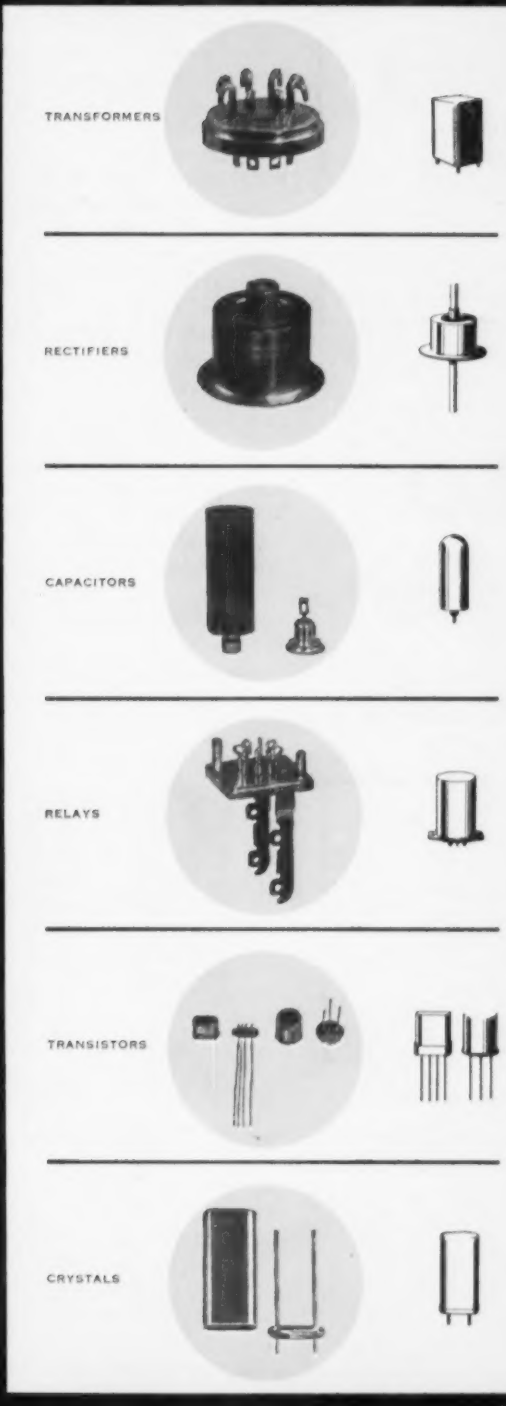
WEINSCHEL ENGINEERING, 10503 Metropolitan Ave., Kensington, Md., has introduced models MS-1 (50 to 250 mc) and MS-2 (250 to 900 mc) modulated r-f sources. They feature high output—at least 200-mw peak power into 50 ohms, 100-percent square-wave modulated internally at 1,000 cps. Amplitude stability is ±0.2 db per hr for constant load; using internal feedback circuit with external probe or coupler, ±0.02 db per hr.

An external directional coupler in conjunction with internal feedback holds the incident power constant over a wide range of load impedances, thereby simulating a constant impedance source equal to the coupler impedance. If a voltage probe is used instead, the voltage is kept constant simulating a zero impedance source. **Circle P9 inside back cover.**

SWEEP GENERATOR
for timing measurements

RADIONICS, INC., Burlington, Mass. Model TWM-2A timing generator has been designed to generate triangular waves of high precision with respect to time period, symmetry and linearity of waveform. Its principal use will be that of

Constantin GLASS-TO-METAL SEALS



Quality

COMPONENTS

DEMAND QUALITY SEALS

Whether you're a designer of transformers, relays, capacitors, rectifiers, diodes, crystals, or any component that needs glass-to-metal sealing . . . insure positive end performance with Constantin Glass-To-Metal Seals.

At Constantin quality comes first. Each and every glass-to-metal seal is manufactured to the closest engineering tolerances . . . and six, separate production line check points maintain these tolerances thru final assembly.

Constantin's precision production is versatile . . . a most complete line of both standard and custom-designed all-in-one assemblies, end seals, transistor mounts, crystal covers, connectors, and unit headers is maintained to fulfill your most exacting demands.

Engineering is of prime importance at Constantin, too . . . over many years Constantin has built up an outstanding reputation for working with designers and delivering many unique and unusual designs.

These many-sided Constantin services can be yours for the asking.

Write for complete design information . . . today!

"Quality With Confidence"

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MANUFACTURING ENGINEERS

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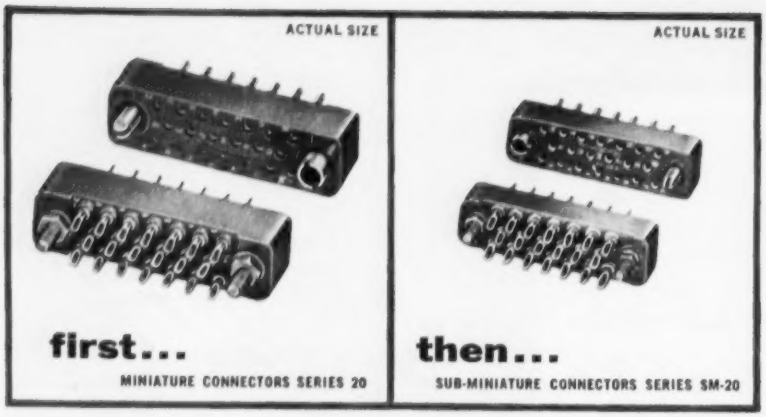
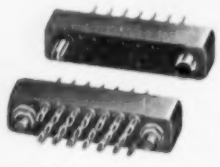


and now

RUGGEDIZED micro-miniature Continental Connectors



Series MM-22 Ruggedized MICRO-MINIATURE CONNECTOR

Available in 7, 11, 14, 20 26, 29 and 34 Contacts. Series 22 can be supplied with hoods and protective shells.

SERIES MM-22, designed for use in miniaturized equipment requiring extremely rugged and compact components, offers the ultimate in miniaturization without sacrifice of performance. No wiring problems are presented by SERIES MM-22, which uses #22 AWG wire, the standard for larger connector types. This Series surpasses the requirements of MIL specifications.

ELECTRICAL AND MECHANICAL RATINGS

Voltage Breakdown:		*Maximum creepage path between contacts*	*1/8"*
At sea level	*1800 Volts RMS*	*Minimum air space between contacts*	*3/64"*
At 60,000 ft.	*450 Volts RMS*	*Contacts, center to center*	*3/32"*
Current Rating	*3 Amps.*	*Pin Diameter*	*.030 inches*
Solder Cup	*#22 AWG Wire*		

you're always sure with **DeJUR** electronic components

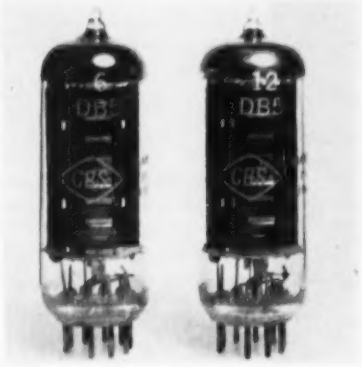
progress in SIGHT SOUND SCIENCE

FOR SPECIAL DESIGNS AND TECHNICAL DATA SHEETS ON THESE CONNECTORS WRITE ELECTRONICS SALES DIV., DEJUR-AMSCO CORPORATION, 45-01 NORTHERN BLVD., LONG ISLAND CITY 1, N. Y.

establishing a crystal-controlled time base sweep raster for oscilloscopic presentation of one-shot phenomena in hypersonic shock tubes, ballistics research, aerodynamic systems research and allied fields.

Marker signals are generated at a frequency exactly 10 times the triangle frequency and are intended primarily for Z-axis modulation so that each triangle period is punctuated accurately by 10 marker dots. Signal phenomena may now be timed to 2 percent of a triangle period and, with several triangles appearing in the sweep raster, this technique allows a much higher time measurement accuracy than is attainable with conventional single-saw-tooth sweeps. Triangle periods are 1,000, 500, 100 and 50 μsec; marker periods are 100, 50, 10 and 5 μsec.

Reliability of time accuracy is guaranteed by scaling-circuit dividers counting down from a crystal reference system. **Circle P10 inside back cover.**



BEAM POWER PENTODES
vertical deflection amplifiers

CBS-HYTRON, a division of Columbia Broadcasting System, Inc., Danvers, Mass., has announced two new tubes designed for use as 110-deg vertical-deflection or audio amplifiers.

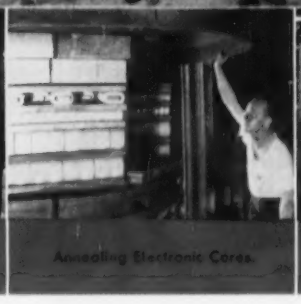
A special feature of the miniature 6DB5 and 12DB5 when pentode-connected in suitable circuits and operated from a 250-v supply is their ability to deflect vertically a 110-deg picture tube.

The new tubes are nine-pin miniature beam power pentodes. Because of their compactness and

MAGNETIC COMPONENTS IN PROTOTYPE OR PRODUCTION RUNS

Slitting grain oriented core steel.

Winding Electronic Transformer Cores.



Annealing Electronic Cores.

40,000,000 volt Pulse Generator for testing Electronic components

Moloney manufactures a line of quality components for electronic applications that comply in detail to ASA, RETMA, Mil-T standards . . . or to your particular requirements. Moloney manufactures for electronics the following products

Plate and Filament Transformers • Chokes • Unit Rectifiers • Modulation Transformers and Reactors Pulse Transformers and Charging Chokes • Developmental Magnetic Components • HyperCores for Magnetic Components

Moloney utilizes industry's finest test facilities for the testing of magnetic components in unlimited KVA and voltage ratings.

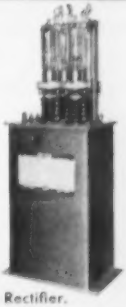
M657-11

MOLONEY ELECTRIC COMPANY

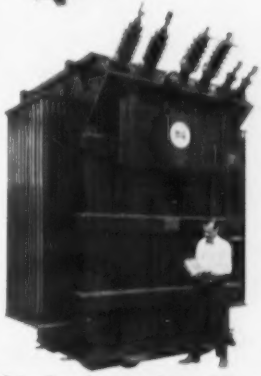
Manufacturers of Transformers for Utilities, Industry, and Electronic Applications

SALES OFFICES IN ALL PRINICPAL CITIES
FACTORIES AT ST. LOUIS 20, MO. AND TORONTO, ONT., CANADA

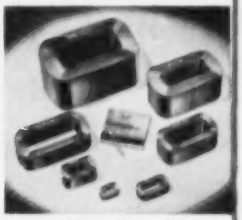
Typical Dry Type Plate Transformer.



Typical Unit Rectifier.

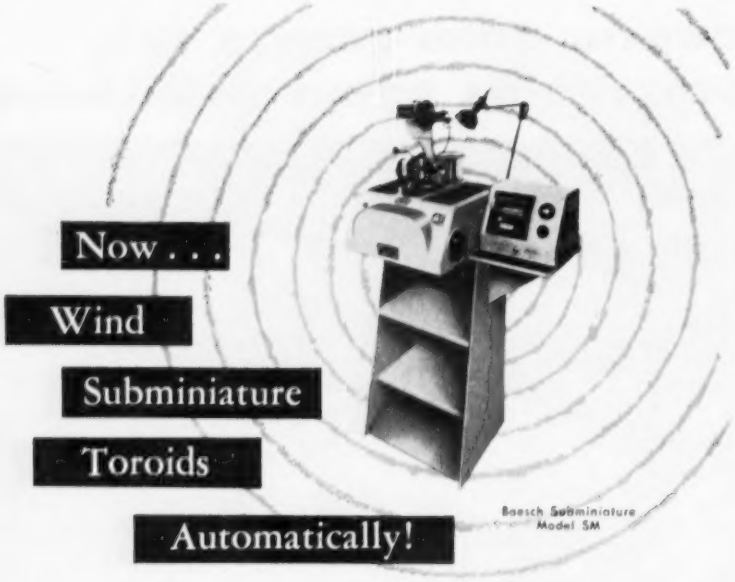


Pulse Transformer—the world's most powerful and largest (over 49,000 lbs.)



HyperCores for electronic applications.

Want more information? Use post card on last page.



Smaller toroids facilitate new designs — open new channels to the coil winding industry

Think of the space . . . weight . . . design problems solved by this machine. Coils with IDs of just 1/16" . . . maximum ODs of 3/4" . . . heights to 1/2" wound automatically with wire sizes as fine as #50! Winding speed is continuously variable from 0 to 800 turns per minute and machine equipment includes every accessory you'll need. Reversing mechanism, wire spacing and core rotation direction controls, wire tension device, automatic linear counter, for example, are just a few of the "custom extras" included as basic parts on Boesch SM. The flexibility offered by this revolutionary machine opens fresh new horizons to the coil winding industry. Get complete details on this Subminiature and all Boesch machinery now. Write today for Catalog 57A.

All Boesch Toroidal Winders . . . Fully-Automatic TW 200, Semi-Automatic TW 201 and Subminiature SM feature modern, adaptable design, easy operation, high speed and life-time parts lubrication.

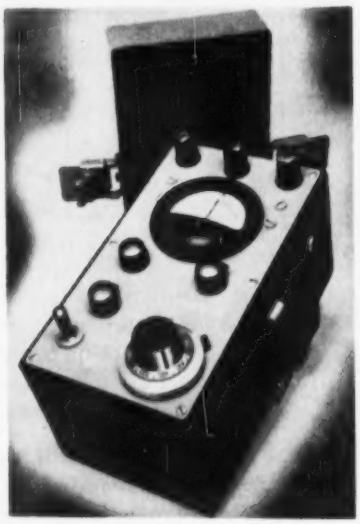
Comparison is the best test of excellence. See for yourself why Boesch manufactures the world's most superior winding machines.

BOESCH MANUFACTURING COMPANY, INCORPORATED
DANBURY, CONNECTICUT

single-ended construction, they are ideally suited to small tv sets or to equipment using printed boards. The tubes are identical except for heater characteristics. The 12DB5 incorporates a 600-ma heater with warm-up control characteristics for use in series strings. Engineering data are given in bulletin E-271. **Circle P11 inside back cover.**

LOW PRESSURE SWITCHES
have high accuracy

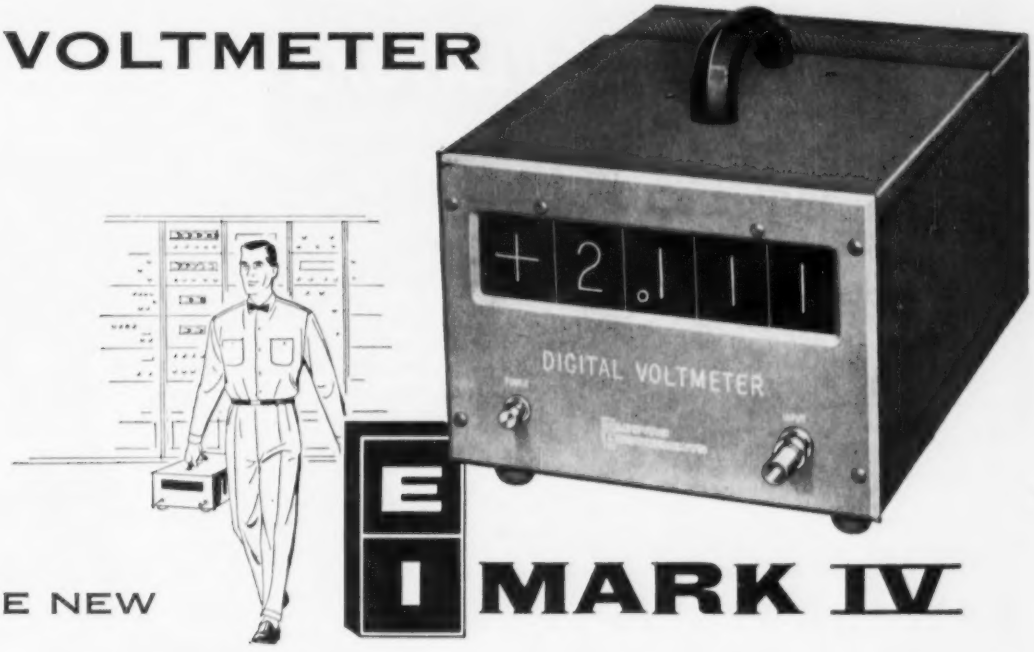
TECHNOLOGY INSTRUMENT CORP., 531 Main St., Acton, Mass., is offering a new line of sensitive low pressure switches designated the 26000 series. These instruments have pressure ranges up to 100 psi and accuracies of better than 1 percent can be expected. They have been designed to minimize the effects of vibrations, shock and acceleration. **Circle P12 inside back cover.**



RATIO METER
measures d-c voltage ratios

ALLEGANY INSTRUMENT CO., INC., 1091 Wills Mt., Cumberland, Md. Model 10 ratio meter can be used to measure d-c voltage ratios (in the range of 0 to 100 percent) for such devices as potentiometers used in aircraft and missile telemetering and measuring systems. Wherever voltage or resistance ratios are more important than

NOW! A PORTABLE, PRECISION DIGITAL VOLTMETER



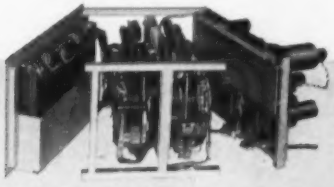
THE NEW E-I MARK IV

This newest E-I instrument provides the perfect general-purpose voltmeter for both laboratory and field use.

Operation is completely foolproof; no manual adjustments or calibrations are required. Measurements are made automatically and results presented digitally with easy-to-read, 1"-high numerals, arranged in line.

A new electronic amplifier design (reducing the number of tubes to only eight!) and advanced miniaturization techniques have reduced the overall size of the new Mark IV to only 7½"x9"x11", and cut the weight to 28 pounds.

Ask your local E-I representative to give you the complete story, or write direct for our new brochure.



UNUSUALLY EASY TO SERVICE

The one-piece hood houses three distinct sub-assemblies: amplifier, power and reference supplies; balance circuit; and read-out. Each sub-assembly is pivoted for excellent accessibility to all parts.

SPECIFICATIONS

Display: four digits, polarity, decimal point.
Range: 0.001-999.9 volts dc.
Ranging: automatic.
Polarity: automatic.
Accuracy: 0.05%, ±1 digit.
Input impedance: 11 megohms.
Average balance time: 1 second.
Calibration: self-calibrated.
Stability: 0.003%/C°.

The complete line of digital instruments

ELECTRO INSTRUMENTS INC.
3794 Rosecrans Street, San Diego, California

Want more information? Use post card on last page.

True Hermetic Sealing assures Maximum Stability in AMPERITE RELAYS and REGULATORS

Simplest • Most Compact • Most Economical

STANDARD

MINIATURE

Thermostatic DELAY RELAYS

2 to 180 Seconds

- Actuated by a heater, they operate on A.C., D.C., or Pulsating Current.
- *Hermetically sealed.* Not affected by altitude, moisture, or other climate changes.
- *SPST only* – normally open or normally closed.

Amperite Thermostatic Delay Relays are compensated for ambient temperature changes from −55° to +70° C. Heaters consume approximately 2 W. and may be operated continuously. The units are *most compact, rugged, explosion-proof, long-lived,* and – *inexpensive!*

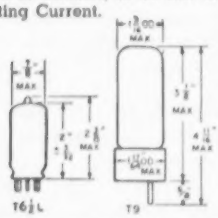
TYPES: Standard Radio Octal, and 9-Pin Miniature

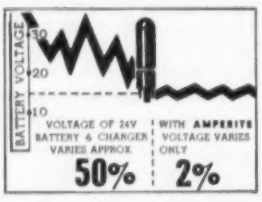
PROBLEM? Send for Bulletin No. TR-81

Also – **Amperite Differential Relays:** Used for *automatic overload, under-voltage or under-current protection.*

BALLAST REGULATORS

Amperite Regulators are designed to keep the current in a circuit ***automatically regulated*** at a definite value (for example, 0.5 amp.) ... For currents of 60 ma. to 5 amps. Operate on A.C., D.C., Pulsating Current.





T9 BULB

Hermetically sealed, they are not affected by changes in altitude, ambient temperature (−55° to +90° C.), or humidity ... Rugged, light, compact, most inexpensive.

Write for 4-page Technical Bulletin No. AB-51

AMPERITE CO., Inc.
561 Broadway, New York 12, N. Y.
Telephone: CAnal 6-1446
In Canada: Atlas Radio Corp., Ltd.
50 Wingold Ave., Toronto 10, Ontario.

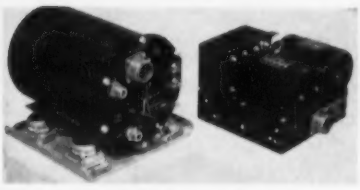
Individual inspection and double-checking assures top quality of **Amperite** products.

absolute values, the model 10 can be conveniently employed.

Very often in aircraft circuitry, potentiometers are used to indicate position, liquid level and the like. The electrical position of the sliders on these potentiometer coils do not always correspond to their linear positions and the model 10 will locate the electrical position to an accuracy of 0.05 percent. **Circle P13 inside back cover.**

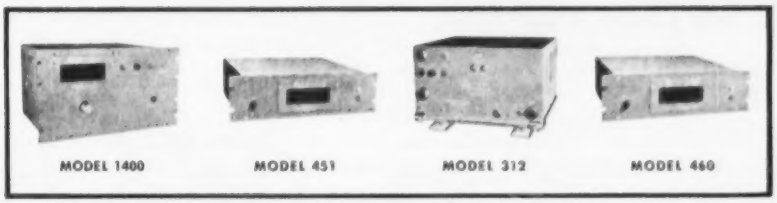
KLYSTRON TUBE
ruggedized, all ceramic

POLARAD ELECTRONICS CORP., 43-20 34th St., Long Island City, N. Y. A ruggedized, all ceramic klystron tube, Velocitron ZV1009—a physical and electrical replacement for klystron tubes 6BL6 and 5836—has been announced. It is designed for high temperature, vibration and mechanical shock. The tube is completely hard-soldered and is equipped with standard four-pin connections. **Circle P14 inside back cover.**



MISSILE BEACONS
feature high reliability

TELERAD MFG. CORP., 1440 Broadway, New York 18, N. Y., an-



It's as simple as 1, 2, 3, for even untrained personnel to clearly and accurately make electrical measurements with NLS digital meters. Inch-high numerals are legible from 30 feet away. NLS originated the automatic digital voltmeter and now manufactures a broad range of these and other precise, related instruments for both laboratory and industry. Accuracy, ruggedness, and dependability are proven features of these digital meters for measuring resistance or voltage. Automatic data recording on Clary printer, electric typewriter, card, or paper punching equipment is available. Whatever your need for high speed, completely reliable electric measurement instruments, you'll find your answer in the NLS complete line. Write on your letterhead for the name and address of your nearest NLS representative, who will be glad to discuss your needs, or mail the coupon for full information on these high precision instruments.

MODEL 1400 Wide Range Voltmeter—Utilizes mercury wetted relays for maximum life and reliability.

MODEL 451 General Purpose Voltmeter—For display or recording of ±0.001 to ±999.9 volts DC.

MODEL 312 High-Speed Voltmeter—For airborne analog-to-digital conversion.

MODEL 460 High Sensitivity Voltmeter—For thermocouple and strain gage systems.

One of the many EXCLUSIVE FEATURES *pioneered by* NLS... *Oil immersed stepping switches that insure trouble-free life and dependable operation.*

Originators of the Digital Voltmeter

non-linear systems, inc.

Del Mar, Calif. • Phone: SKyline 5-1134

Digital Ohmmeters • AC-DC Converters • Data Reduction Systems • Digital Readouts • Peak Reader Systems • Binary Decimal Converters • Digital Recording Systems

100

NON-LINEAR SYSTEMS, INC.
Dept. D-547 Del Mar Airport, Del Mar, Calif.
Please send technical information on:
☐ AC or DC voltmeters ☐ ohmmeters
☐ analog-to-digital converters ☐ automatic testing systems

NAME _____
COMPANY _____
ADDRESS _____
CITY _____ ZONE ____ STATE _____

Want more information? Use post card on last page.

SAR PULSESCOPE

by Waterman

MODEL S-4-C

DIRECT-READING DELAYED SWEEP ACCURATE TO 0.1%

Size:
9⅛" x 11¼" x 17¼"
31.5 Pounds

ANOTHER EXAMPLE OF Waterman PIONEERING...

The SAR PULSESCOPE, model S-4-C, is JANized (Gov't Model No. OS-4), the culmination of compactness, portability, and precision in a pulse measuring instrument for radar, TV and all electronic work. An optional delay of 0.55 microseconds assures entire observation of pulses. A pulse rise time of 0.035 microseconds is provided thru the video amplifier whose sensitivity is 0.5V p to p/inch. The response extends beyond 11 mc. A and S sweeps cover a continuous range from 1.2 to 12,000 microseconds. A directly calibrated dial permits R sweep delay readings of 3 to 10,000 microseconds in three ranges. In addition, R sweeps are continuously variable from 2.4 to 24 microseconds; further expanding the oscilloscope's usefulness. Built-in crystal markers of 10 or 50 microseconds make its time measuring capabilities complete. The SAR PULSESCOPE can be supplied directly calibrated in yards for radar type measurements. Operation from 50 to 400 cps at 115 volts widens the field application of the unit. Countless other outstanding features of the SAR PULSESCOPE round out its distinguished performance.

WATERMAN PRODUCTS CO., INC.

PHILADELPHIA 25, PA.
CABLE ADDRESS: POKETSCOPE

MEMO... Write for details today!

WATERMAN PRODUCTS

MANUFACTURERS OF

PANELSCOPE®
S-4-C SAR PULSESCOPE®
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S-12-B JANized RAKSCOPE®
S-12-C SYSTEMS RAKSCOPE®
S-14-A HIGH GAIN POCKETSCOPE®
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S-14-C COMPUTER POCKETSCOPE®
S-18-A TWIN TUBE POCKETSCOPE®
RAYONIC® Cathode Ray Tubes and Other Associated Equipment

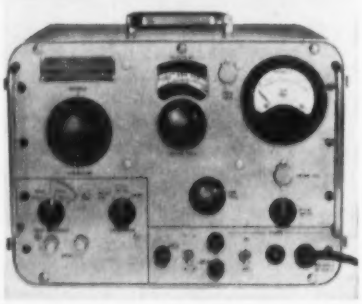
®T. M. REG.

nounces reliable guided missile beacons available in S and L band. The units have successfully completed 1,000-hr tests including all environmental conditions: salt spray, dust, vibration, hot and cold cycling as required under the new Missile Reliability Program. These beacons and related power supplies are presently in use by aircraft and missile manufacturers. Further information is available from the company. **Circle P15 inside back cover.**

HEAVY TEFLON TAPES
in thicknesses to 3/16 in.

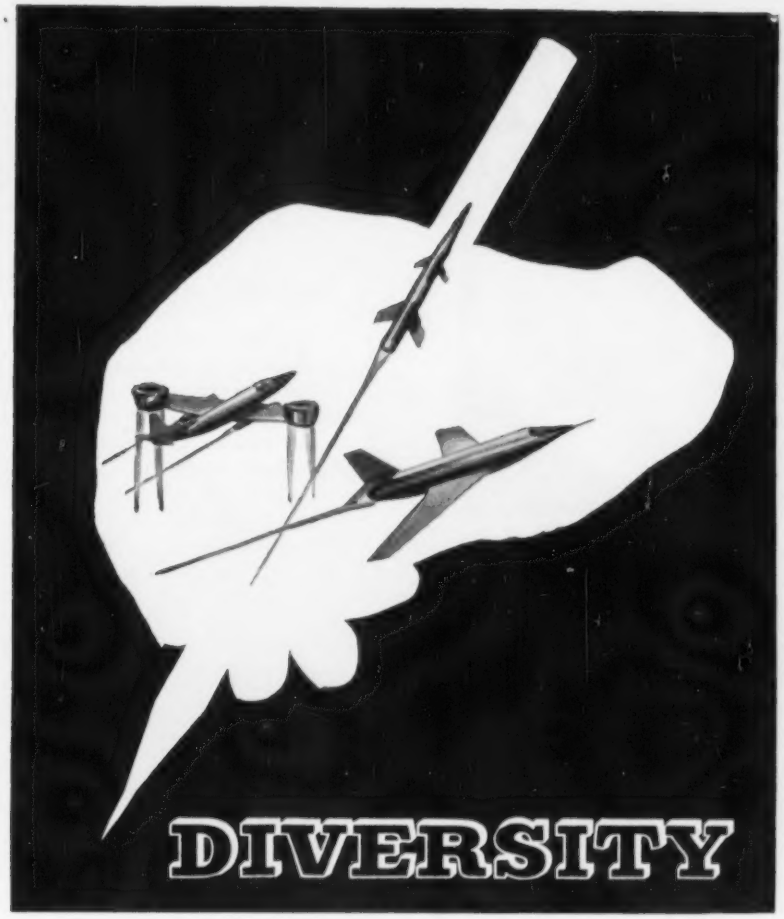
ENFLO CORP., Airport Circle, Route 38, Pennsauken, N. J. Based on a new fabricating method, Teflon continuous-roll tapes in thicknesses to $\frac{3}{16}$ in. have been developed. Lengths from 40 ft to several-hundred feet are available in thicknesses of $\frac{1}{32}$ in., $\frac{1}{8}$ in., $\frac{3}{32}$ in. and $\frac{3}{16}$ in. Maximum width varies from 6 in. to 12 in. depending on thickness.

The tapes are available in virgin Teflon, TFMC (mechanical-chemical) and Enflon (filled Teflon) and also in cementable or pressure-sensitive types. Samples as well as a copy of the complete Teflon products catalog are available. **Circle P16 inside back cover.**



WAVE ANALYZER
a carrier frequency voltmeter

MACK ELECTRONICS DIVISION, INC., 1120 South Second St., Plainfield, N. J. The CF-83 is a precision harmonic wave analyzer capable of measuring the amplitude of signals and harmonics from 10 kc to 500 kc. It is essentially a highly tuned frequency selective detector



BUILDS JOB INTEREST at **BELL**

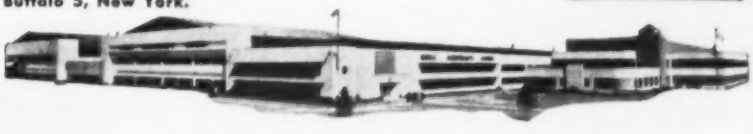
Bell's activities are widely diversified — experimental and vertical rising aircraft, rockets and rocket engines, missiles and guidance systems, electronics, servomechanisms and nucleonics to name only a few. Such diversity means broad fields of interest for engineers and technical personnel—insurance against boredom and assignments too limited in scope to let you go as fast and as far as you are capable.

Bell is progressing, growing and expanding. There are openings at all levels and in all fields as listed at the right. If you are looking for a move that offers every opportunity for a permanent career with professional growth and recognition and capable, congenial associates, contact Bell.

For further information regarding employment opportunities in the Weapon Systems Division or the Aircraft Division of Bell Aircraft, write today: Manager, Technical Employment, Dept. H22, Weapon Systems Division.

BELL AIRCRAFT CORPORATION, P. O. Box One, Buffalo 5, New York.

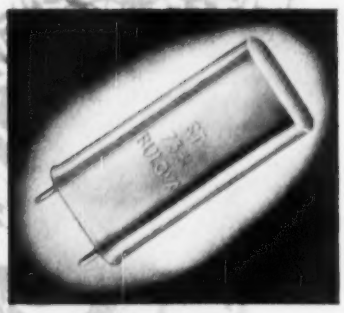
BELL Aircraft corp



- Aerodynamicists
- Aeronautical Engineers
- Automatic Control Designers
- Chemical Engineers
- Combustion Research Engineers
- Communications Engineers
- Design Checkers
- Development Engineers
- Digital Computer Development Engrs.
- Dynamic Engineers
- Electronic Engineers
- Electronic Standards Engineers
- Engineering Computors
- Environmental Specialists
- Field Test Engineers
- Flight Test Engineers
- Flight Test Programmers
- Fuel Injection Specialists
- Gear Designers
- Guidance Engineers
- Gyro Specialists
- Heat Transfer Engineers
- Hydraulic Engineers
- IBM Programmers
- Instrumentation Specialists
- Laboratory Test Engineers
- Magnetic Amplifier Specialists
- Mathematical Analysts
- Mechanical Engineers
- Microwave Engineers
- Miniturization Engineers
- Nuclear Physicists
- Operations Analysts
- Physicists
- Power Plant Designers
- Pressure Vessel Designers
- Project Engineers
- Publication Engineers
- Radar Systems Engineers
- Reactor Designers
- Reliability Engineers
- Rocket Test Engineers
- Servo Systems Engineers
- Servo Valve Engineers
- Statisticians
- Stress Engineers
- Structures Engineers
- Specification Writers
- Technical Writers
- Test Equipment Engineers
- Transformer Design Specialists
- Transistor Application Engineers
- Thermodynamic Engineers
- Telemetering Engineers
- Turbine Pump Designers
- Vibration & Flutter Analysts
- Weapons Systems Engineers
- Wave Guide Development Engineers
- Weights Engineers

BULOVA

FAMED FOR PRECISION SINCE 1875



NEW ST-73X

"SHOCK MOUNTED" QUARTZ CRYSTAL

The Bulova ST-73X need never be babied. Effective new shock mounting and traditional Bulova manufacturing precision result in a rugged, extremely stable, frequency determining element for missiles, aircraft and other applications involving extreme environmental problems.

Where frequencies must be maintained with ultra-reliable stability under high shock and temperature conditions, you'll find no adequate substitute for Bulova quality.

THE ST-73X FEATURES: Frequency Range from 16 KC through 350 KC, with lower frequencies possible in holders of different configuration; Shock Tests of 100 G; Dynamic vibration tests met per MIL-T-5422, MIL-E-5272 and MIL-E-5400 without adverse results; Storage Temperatures over a range of −65°C. to +135°C. can be coupled with an operation temperature range of −55°C. to +100°C.; Low excursions of frequency (±.015%) over this range.

Precision Bulova Quartz Crystals are now available in quantity for frequencies from 16 KC and lower to 100 MC and above.

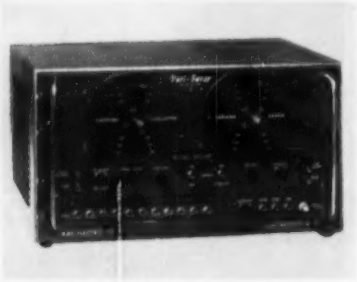
BULOVA
watch company

Electronics Division
Woodside 77, N.Y.

Write Dept. A-738 For Full Information and Prices on Quartz Crystals

designed for voltage measurements on carrier telephone systems as well as precise measurement of the harmonic content of various types of waveforms. The linearity of response is sufficient to permit measurements of harmonics at least 60 db below the fundamental.

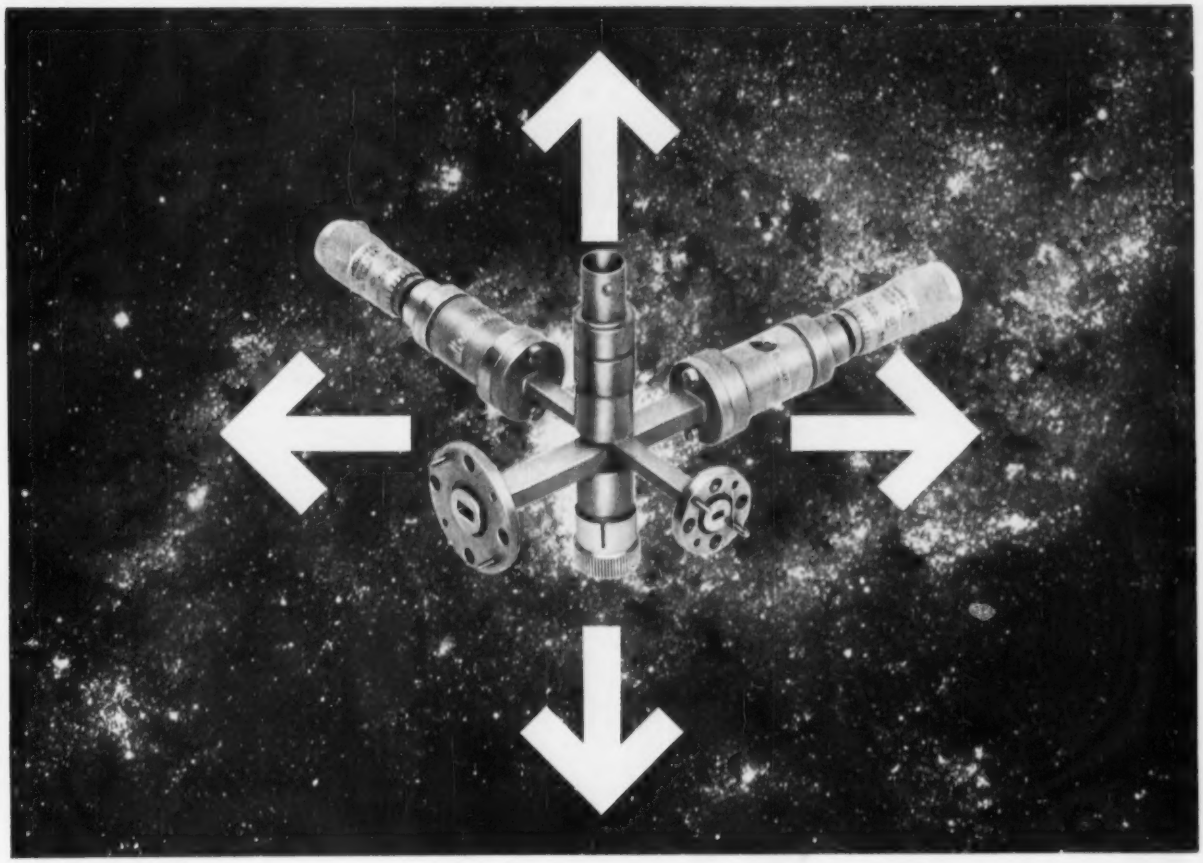
The instrument features an r-f attenuator that insures accurate measurements down to the microvolt region. The tuning oscillator utilizes a precision tuning capacitor ruggedly mounted on an aluminum casting for high stability with rough usage. A rugged 12-to-1 antibacklash gear reduction system allows for ease of tuning with no sacrifice in resetability. **Circle P17 inside back cover.**



ALIGNMENT INSTRUMENT
for 10 to 145 mc range

KAY ELECTRIC CO., 14 Maple Ave., Pine Brook, N. J., has announced the Vari-Sweep Model Radar, a complete new alignment instrument—sweeping oscillator, calibrated variable-frequency marker and fixed crystal controlled markers—designed for the 10 to 145 mc range.

The fundamental-frequency sweeping oscillator is continuously variable in six overlapping bands accurately calibrated on a direct-reading dial. Sweep widths variable to 60 percent of center frequency below 50 mc, 30 percent above 50 mc are provided. R-F output voltage is 1.0 v rms into 70 ohms, with agc for ±0.5-db flatness over widest sweep and tuning range. The variable marker is a birdie pip marker generated by a separate c-w oscillator continuously variable from 5 to 170 mc in six overlapping bands and calibrated to ±1 percent on a



MICROWAVE RESEARCH EXTENDED TO 140,000 MC!

now you can enter Ultramicrowave research with this complete new line of* **D-B** *test instruments*

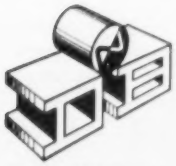
Now microwave engineers can plunge into new research territory. With this 140 KMC Crystal Multiplier (harmonic generator) to provide higher frequencies, and eleven other instrument sizes available for testing, researchers can experiment with 50% more latitude.

For example, you can build working models only 1/10 actual size. You can get better resolution with these higher frequencies – better by 10 to 1.

Here are crystal mounts, precision attenuators, variable stub tuners, standing wave detectors, phase shifters, frequency meters – every type of instrument used from 2.6 KMC to 90 KMC. All are now available in continuous coverage to 140 KMC!

No matter what your research field, it will pay you to consider the application of ultramicrowaves to your problems. De Mornay-Bonardi will help your staff plan special systems, and set up test equipment. You'll be receiving experienced assistance, too – 14 years of leadership in microwave instruments.

WRITE FOR FURTHER INFORMATION



*TRADE MARK DE MORNAY-BONARDI CORPORATION

DE MORNAY-BONARDI *780 s. arroyo parkway • pasadena, california*

Want more information? Use post card on last page.

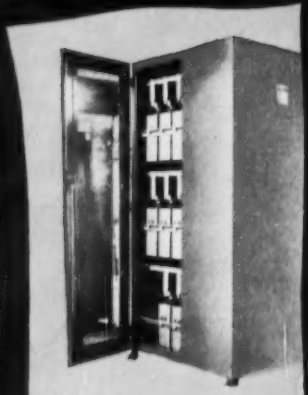
CAPACITORS

Standard! Special! Unusual!

AEROVOX makes them all . . . from the largest capacitors for heavy duty, high-voltage applications to micro-miniature units for critical requirements in guided missiles. And . . . capacitors need not conform to conventional shapes, but can run the gamut of physical configurations. Illustrated here are just a few of the many unusual capacitors Aerovox has been called on to design and produce in recent months.

SPECIAL . . . bracket or "hat-type" mounting assembly for a standard bathtub capacitor.

SMALL . . . only .175" D x 3/16" L., this hermetically-sealed metal cased unit is rated at .01 mfd at 200 vdc.



BIG . . . rack-mounted oil units for energy storage and pulse applications.

MULTI-SECTION . . . one of the many multi-section capacitors designed for critical military applications.

UNUSUAL . . . metal cased mica capacitor for application in high power sonar equipment.

TOROIDAL . . . in shape is this hermetically-sealed filter for RF noise suppression usage.

SLIM . . . and this metallized-paper capacitor designed for a special application.

Maybe these unusual shapes and designs offer suggestions for your capacitor requirements. If so, write . . .

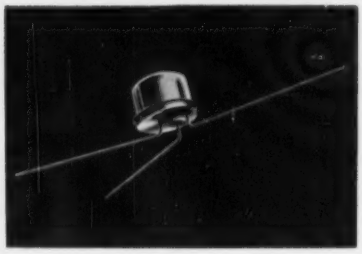
AEROVOX CORPORATION

New Bedford, Mass.

In Canada: AEROVOX CANADA, LTD., Hamilton, Ont.

Export: Ad. Auriema., 89 Broad St., New York, N. Y. • Cable: Auriema, N. Y.

separate direct-reading dial. Eleven individually switched, crystal-controlled pulse type markers at customer specified frequencies over the bandwidth are provided for both separate and simultaneous operation. **Circle P18 inside back cover.**



PNP TRANSISTORS
for high-speed switching

GENERAL TRANSISTOR CORP., 91-27 138th Place, Jamaica, N. Y., has developed three high speed switching transistors. The new *pnp* computer transistors, the 2N-315, 2N-316 and 2N-317 are germanium alloy types intended primarily for applications where high-speed, high-current switching is of paramount importance.

The 2N-317 has, with only a minimum of drive current, a typical switching speed of 0.3 μsec at 400 ma of collector current. The series resistance of these transistors when conducting is $\frac{1}{2}$ ohm. The nonconducting series resistance is as high as 10 megohms with a result that approaches optimum efficiency at high current levels. **Circle P19 inside back cover.**

SERVO AMPLIFIER
for computer use

BELOCK INSTRUMENT CORP., 110-01 14th Ave., College Point, N. Y., has designed and developed a new transistor servo amplifier for use in electronic and electromechanical computers that requires no expensive preamplifier or power amplifier components. This servo amplifier plugs into a standard octal socket and occupies a volume of only 9 cu in. It is completely encased, providing high immunity from shock and hu-

NEW General Electric M-2 Leak Detector Offers You

UNSURPASSED LEAK SENSITIVITY

Expensive rejects of sealed electronic products can be reduced by leak testing housings before assembly with the new General Electric mass spectrometer leak detector. It offers:

EXTREME SENSITIVITY—detects leaks of 1×10^{-10} standard cubic centimeters of air per second (9×10^{-6} micron cubic feet per hour).

FAST RESPONSE—as low as 2 seconds for small, hermetically sealed electronic components.

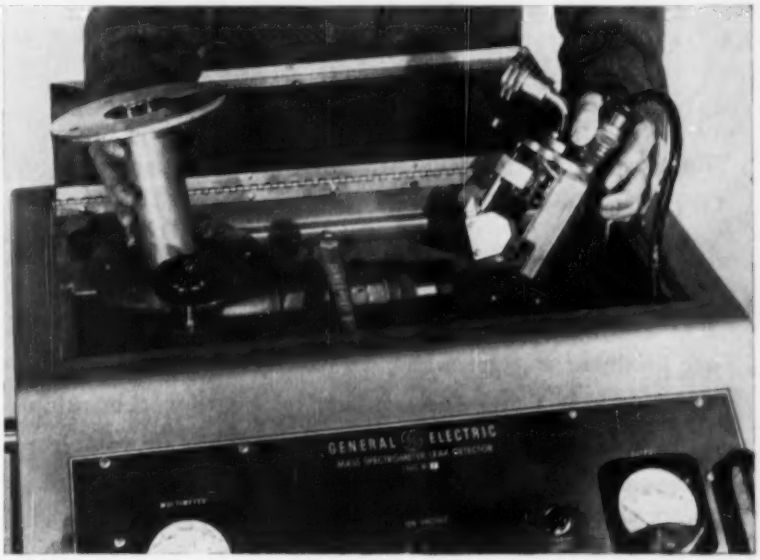
HIGH RESOLUTION which helps eliminate the possibility of response to elements other than the tracer gas.

THESE EASY MAINTENANCE FEATURES HELP REDUCE DOWN-TIME

SIMPLIFIED DESIGN of the vacuum system and use of plug-in components gives excellent accessibility and saves maintenance time. The easily removed spectrometer tube greatly reduces down-time when the tube needs cleaning or filament replacement.

NO SPECIAL TRAINING is needed to operate the General Electric M-2 leak detector. After starting, the M-2 is operated simply by opening and closing one valve. The leak will show up on the leak rate indicator of the operator's panel. An audible alarm is also available.

FOR FURTHER INFORMATION, contact your nearest General Electric Apparatus Sales Office or write for descriptive bulletin, GEC-336, to Section 585-63, General Electric Co., Schenectady 5, N. Y.



DOWN-TIME IS REDUCED through easy access and removal of the spectrometer tube (right) and by a simplified vacuum system design.

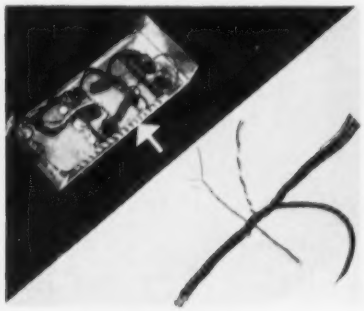
GENERAL ELECTRIC

A special porcelain body is used in the production of Lapp Resistor Cores. It provides a flawless surface of such nature as properly to receive a uniform deposit of carbon or boro-carbon. It also has a temperature coefficient of expansion matched to that of the deposited film . . . to provide a constant resistance against temperature change. These resistor cores are produced in close tolerances for straightness, roundness and length . . . they reflect the same quality of workmanship and materials long associated with Lapp. Write for complete information on Lapp Resistor Cores. Lapp Insulator Co., Inc., Radio Specialties Division, 130 Sumner St., LeRoy, N. Y.

Lapp

midity. It operates instantly, requiring no warmup time. The elimination of auxiliary filament and plate power has been achieved.

The amplifier is ideally suited for airborne application since it operates on 28 v d-c. Its performance is equal to a complete 4 or 5 tube servo amplifier with no heat dissipation problem. **Circle P20 inside back cover.**



CABLE HARNESS
known as Spiral Wrap

ILLUMITRONIC ENGINEERING, 680 E. Taylor, Sunnyvale, Calif., announces a new product known as Spiral Wrap, that is designed to simplify the harnessing of loose wires into neat cables. Made from polyethylene tubing in ¼ in. and ⅜ in. diameters, and cut into a spiral pattern, it will wrap easily around loose wires to make cables in any diameter up to 2 in. Wires may be pulled out at any desired position.

Spiral Wrap offers great flexibility, whether used in prototype lab work or mass production. It is initially low in cost and will save many hours of labor. **Circle P21 inside back cover.**

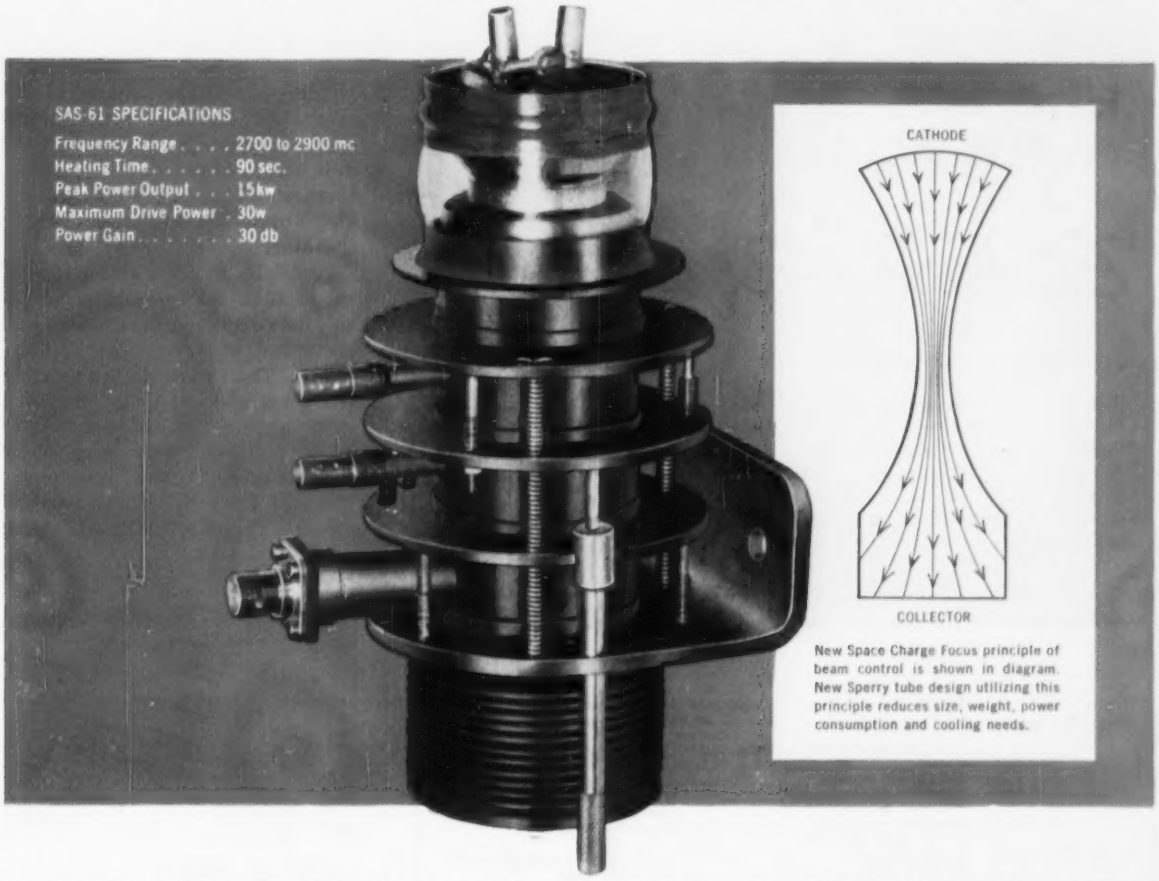
POWER SUPPLY
with excellent regulation

DELTRON INC., P. O. Box 192, Glenside, Pa. Model H-3615 power supply is a versatile laboratory source of variable d-c voltage, capable of supplying large load currents up to 15 amperes. It features an output voltage range continuously variable from 2 to 36 v with regulation accuracy of ±½ percent for combined variations of line

IMMEDIATE DELIVERY

15kw S-Band Amplifier Klystron has **no heavy magnets**

Exclusive Space-Charge Focus cuts weight to only 6½ lbs.


SAS-61 SPECIFICATIONS
Frequency Range . . . . 2700 to 2900 mc
Heating Time . . . . . 90 sec.
Peak Power Output . . . 15kw
Maximum Drive Power . 30w
Power Gain . . . . . 30 db
CATHODE
COLLECTOR
New Space Charge Focus principle of beam control is shown in diagram. New Sperry tube design utilizing this principle reduces size, weight, power consumption and cooling needs.

Available for immediate delivery, Sperry's new S-band transmitting tube is a 3-cavity pulse amplifier of high gain and extra-long service life.

Exclusive Sperry Space-Charge Focusing design eliminates heavy, cumbersome magnetic structures—a feature of prime importance in equipment design. Although the SAS-61 weighs only 6½ lbs., its sturdy construction withstands extreme vibration and environmental conditions.

Main applications for the SAS-61 are as an output tube in low-power radars, or as a driver for higher-powered klystrons in radar and linear accelerator systems. Its unusually long service life, however, makes it highly desirable for any application requiring 15 kw in the S-band. The SAS-61 with its internal tunable cavities is a *complete* microwave unit. No external equipment is required.

Sperry can deliver SAS-61 tubes in quantity at once. Write or phone your nearest Sperry district office.

ELECTRONIC TUBE DIVISION

SPERRY GYROSCOPE COMPANY

Great Neck, New York

DIVISION OF SPERRY RAND CORPORATION

CLEVELAND • NEW ORLEANS • BROOKLYN • LOS ANGELES • SAN FRANCISCO • SEATTLE • IN CANADA: SPERRY GYROSCOPE COMPANY OF CANADA, LIMITED, MONTREAL, QUEBEC

Want more information? Use post card on last page.

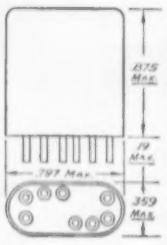
ELGIN'S NEW MV

Big Relay Performance!

...crystal can size

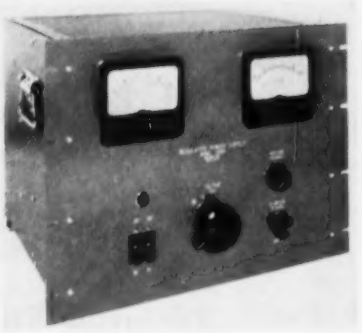
Elgin's new MV rates superior to other high performance relays, yet is less than an inch long and weighs less than half an ounce. It meets military specifications and is designed for continuous use in the —65°C to 125°C temperature range. The MV has a life rating of 100,000 operations minimum at rated load. This new relay is in production now and prompt delivery is assured. For computers, control systems and every installation that requires dependable performance AND miniature size . . . specify MV.

SPECIFICATIONS



VIBRATION	10 to 80 cycles per second at maximum excursions of .06"—80 to 2000 CPS 20G's acceleration
SHOCK	50G for 11 milliseconds
LIFE	100,000 operations minimum at rated current
AMBIENT TEMPERATURE RANGE	—65°C to 125°C
DUTY	Continuous
OPERATING POWER	Nominal 1.2 watts at ambient temperature
CONTACT ARRANGEMENT	DPDT (2 Form C)
CONTACT RATING	2 amps resistive at 32VDC or 115VAC
CONTACT MATERIAL	Silver-Magnesium-Nickel Alloy
CONTACT RESISTANCE	.05 ohms
OPERATING TIME	5 milliseconds maximum at nominal power
RELEASE TIME	5 milliseconds maximum
ALTITUDE	Voltage breakdown of relay is 1000 Volt AC to 40,000 ft.—550 Volts AC to 70,000 ft.
DIELECTRIC STRENGTH	1000 volts RMS
INSULATION RESISTANCE	100 megohms minimum at 125°C
STANDARD COIL RESISTANCES	30, 120, 600, 1000, 2500, 5000, 10000 ohms, others available
SIZE	.875 high x .797 wide x .359 thick max.
WEIGHT	0.45 ounces (max.)
MOUNTING ARRANGEMENT	Bracket, side studs, top studs
TERMINAL ARRANGEMENT	Plug-in, solder-hook, 3-inch leads

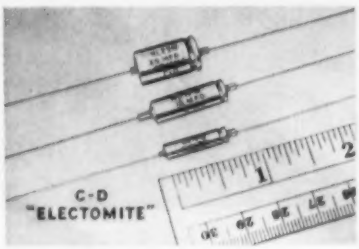
ELECTRONICS DIVISION
ELGIN NATIONAL WATCH COMPANY
107 National Street, Elgin, Illinois
2435 N. Naomi Street, Burbank, California



from 105 to 125 v and load from 0 to 15 amperes.

It has less than 0.25-percent ripple making the unit ideal for laboratory and test applications. Completely overload protected, the unit has a unique overload voltage feature which prevents voltage rise above the value set by the operator.

Model H-3615 has a response of better than 0.2 sec and is adaptable to computer, laboratory, aircraft and other critical applications. The unit is completely self-contained and is provided with large 4½ in. meters. It can be used either bench mounted or rack mounted. The instrument operates from either 50 or 60-cps power. **Circle P22 inside back cover.**



ELECTROLYTICS

tiny aluminum-foil type

CORNELL-DUBILIER ELECTRIC CORP., South Plainfield, N. J. Designed expressly for transistorized and printed circuits, and other compact or miniaturized low-voltage d-c equipment, the new Electomite type NL electrolytics meet the demand for ultracompactness in bypass, filter and coupling applications.

Available in d-c working voltages of 1, 3, 6, 10, 15, 25 and 50 v, in capacitances from 1.0 to 200 μf,

Systems engineering–38th parallel style

Here's the challenge we received from the Korean Civil Assistance Command and the U. S. Army Signal Corps:

Build a telephone communications system to their specifications that will function over mountainous terrain. Cost to be within reasonable limits . . . upkeep minimum . . . equipments compatible with the experience and background of the population.

The answer is the system now being installed in South Korea.

Manually operated telephones, central offices and PBX switchboards, suited to a civilian population unfamiliar with dial methods.

Wire lines for basic country-wide linkage, augmented with many channels of *Carrier,* wherever estimated traffic warrants it.

And—delivery on schedule.

S-C STROMBERG-CARLSON COMPANY GD

A DIVISION OF GENERAL DYNAMICS CORPORATION

General Offices and Factories at Rochester, N. Y.—West Coast plants at San Diego and Los Angeles, Calif.

how to put more profit into your product ...in your design

Engineering projects can be completed quicker . . . Laboratory and production operations speeded up . . . Greater profits retained . . .

BECAUSE

PANORAMIC'S NEW SONIC ANALYZER LP-1a

Used in designing, improving and production testing:

Ball bearings
Jet and reciprocating engines
Electric motors
Home appliances
Business machines
Pumps
Blowers and fans
Compressors
Air frames
Tire performance
Any rotating or oscillating machinery.

provides high-speed visual analysis of sounds, vibrations and electrical waveforms . . . identifies mechanical and electrical defects or variations.

Versatile, flexible, fast. In only one second the LP-1a depicts the frequencies and amplitudes of sound or vibration waveform components, eliminating tedious, complicated point by point measurements. Makes possible observation of changes in energy distribution while the waveform itself varies or while design constants are altered.

Data presented graphically for direct reading. Optional companion recorder permits permanent recordings of waveform content over extended periods. Tuning control and three-step scanning range allow sharp, detailed analysis. A valuable aid designwise or productionwise.

the pioneer is the leader

PANORAMIC
RADIO PRODUCTS, INC.

Get complete details on how a Panoramic Sonic Analyzer can help you.

Descriptive data sheets, prices, delivery schedules sent on request. A Panoramic Application Engineer will be glad to discuss your Spectrum Analysis problems with you. Special instruments to order.

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Cables: Panoramic, Mt. Vernon, New York State

These organizations have found Panoramic equipment PROVED PERFORMERS:—Allis-Chalmers Mfg. Co., Bell Aircraft Corp., Bell Telephone Co., Boeing Airplane Co., California Institute of Technology, Chrysler Corp., Convair, Cornell University, Curtiss Wright, Dept. of Defense, E. I. Dupont de Nemours & Co., Eastman Kodak Co., Ford Motor Co., General Electric Co., General Motors Corp., Hot Point Co., Lockheed Aircraft Corp., Massachusetts Institute of Technology, Philco Co., Pratt & Whitney Aircraft, Radio Corporation of America, Sperry-Gyroscope Co., U. S. Testing Co., Inc., Western Electric.

and in sizes from $\frac{3}{4}$ in. by $\frac{1}{2}$ in. to $\frac{3}{4}$ in. by 1 in., these units can be operated within the temperature range of −20 to +85 C.

Electomite capacitors are compression-sealed and resistant to moisture and humidity. Terminal leads are tinned copper wire. The positive lead is connected to the anode through the rubber bushing of the compression seal and the negative lead is grounded to the aluminum can.

They are also available with outer plastic insulating sleeves where physical contact with adjacent components is a design requirement. Bulletin 533 gives complete specifications. **Circle P23 inside back cover.**

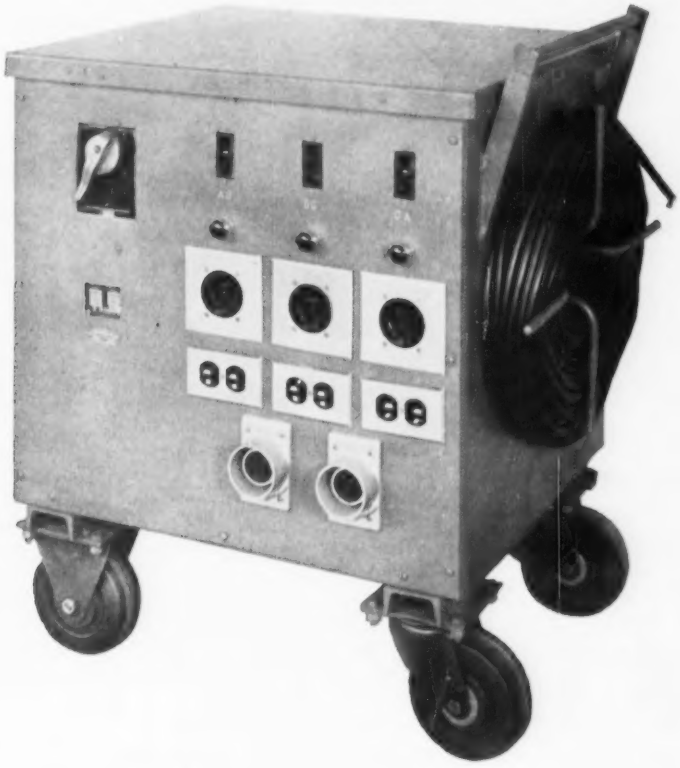
MICROWAVE DIODE
for X-ray circuitry

MICROWAVE ASSOCIATES, INC., Burlington, Mass., has available a new high-sensitivity microwave silicon diode for use as a low-level detector in X-band video receiver circuitry. Typical applications for the MA-408B are missile guidance, radar beacon, telemetering and low-level video receivers. Minimum figure of merit for this video diode is 220. Theoretical tangential sensitivity is −53 dbm at 9,000 mc for a receiver bandwidth of 10 mc. For highest sensitivity performance a d-c bias of +50 μa is recommended.

The MA-408B is interchange-

NWL Nothelfer

PORTABLE LOW VOLTAGE TESTER



The newest development in the Nothelfer line, is this portable low voltage tester for on-the-field use. It is used for testing of motor transformer relays or other electrical components under full load.

The unit illustrated here has an output of 15KVA, 3 phase, and also 5KVA, single phase, in voltage output and input of 120 to 480 volts. The unit can also be made to put out 2 phase power if required.

For over 30 years NWL has designed and manufactured custom transformers for every application. Only high standard materials and most reliable manufacturing methods are used. NWL coils are vacuum impregnated with the best of varnishes. Joints over 10 amperes are silver plated. All laminations and grain-oriented core steels, and most silicon steels are annealed in controlled nitrogen atmosphere electric furnaces.

NWL
ESTABLISHED 1920
NEMA
Nothelfer

WINDING LABORATORIES, INC.
P. O. Box 455, Dept. 101, TRENTON, N. J.

Want more information? Use post card on last page.

REVERE Thermocouple Wires

bought FIRST because they LAST

Day in, day out . . . in aircraft, refinery vessels, fire protection systems, furnaces, molding presses . . . under extremes of heat and cold, moisture, chemicals and abrasion, Revere thermocouple wires stand up because they're tailor-made for each application.

Solid or stranded chromel-alumel, iron-constantan and copper-constantan conductors available in various gauge sizes. Wrapped, carded or extruded insulations include polyethylene, vinyl, nylon, Revcothene*, Teflon†, fiber glass, asbestos and pure silica glass fiber. Outer braids treated with flame and abrasion resistant saturants. Metallic braids for severe service. L & N, SAMA or NBS calibration. Wires constructed to Military Specifications MIL-W-5845, MIL-W-5846 and MIL-W-5908.

Whether your application requires extreme flexibility, chemical inertness or resistance to temperature, flame, abrasion, moisture, acids or solvents, a standard or special Revere thermocouple wire will meet your specific need.

*Revere trade name †E. I. DuPont trademark

Send for Engineering Bulletin No. 1701 describing Revere Thermocouple Wires and Extension Leads.

Revere CORPORATION OF AMERICA 21

WALLINGFORD, CONNECTICUT A Subsidiary of Neptune Meter Company

able with other cartridge type diodes of the IN23 series. An average improvement of 4 to 5 db is indicated when the MA-408B replaces IN23C mixer crystals in low-level video circuitry. The new crystal is approximately 2 db more sensitive than the MA-408A. **Circle P24 inside back cover.**

WIRE-WOUND RESISTORS
for use in small spaces

THE DAVEN CO., 530 West Mt. Pleasant Ave., Livingston, N. J., has available two new toothpick-type wirewound resistors, specially designed for use in applications where minimum space is a prime factor, such as in guided missiles and airborne radar and communications equipment.

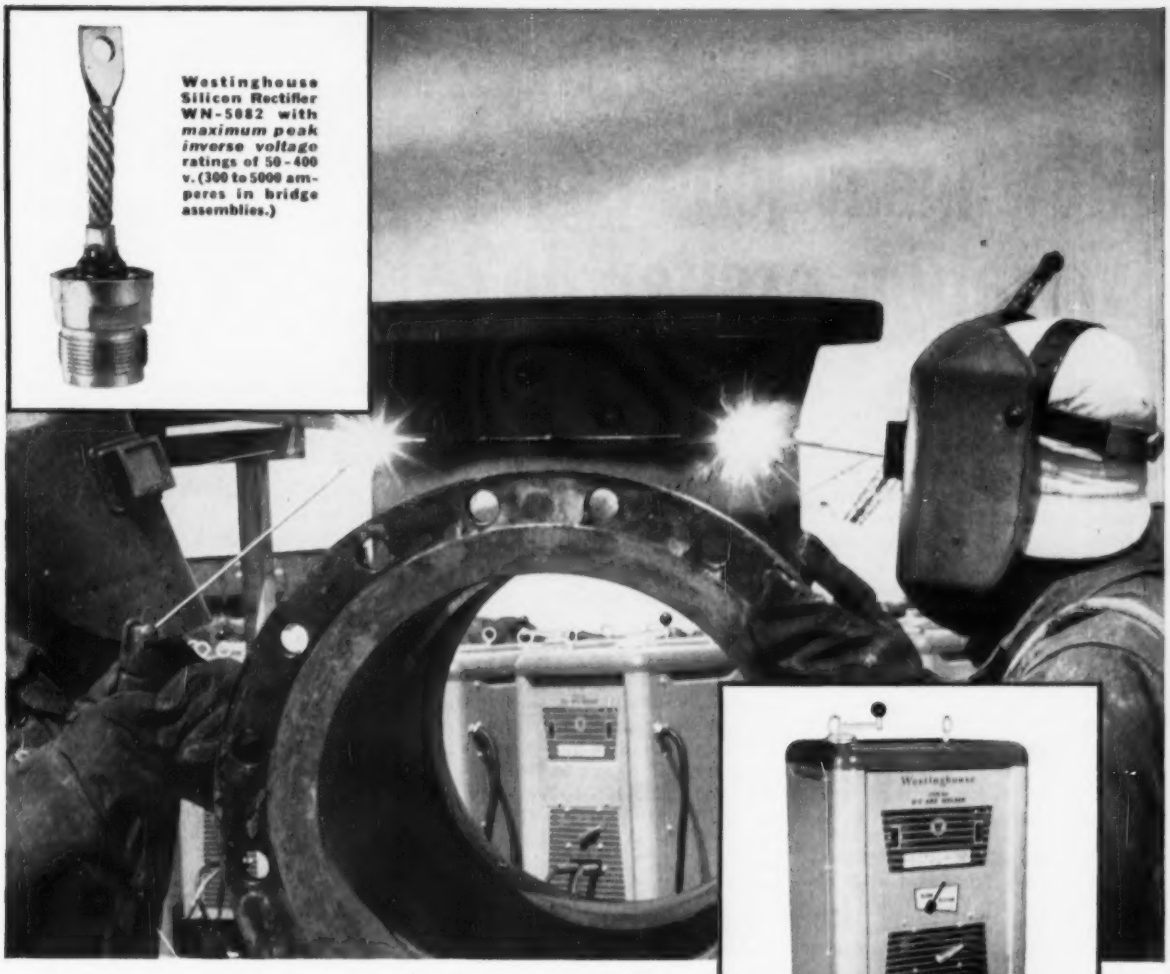
Standard tolerance of both of these resistors is ±1 percent, but certain values can be obtained as close as ±0.1 percent. The smaller resistor (type 1288) measures 1 in. long by ¼ in. diameter; its maximum resistance is 100 K and it dissipates 0.15 w. Type 1289 measures 2 in. in length by ¼ in. diameter. Its maximum resistance is 200 K and it dissipates 0.20 w.

Both are noninductive. These units will pass all environmental requirements of MIL-R-93-A, Amendment 3. **Circle P25 inside back cover.**

STEP ATTENUATOR
d-c to 1,000-mc unit

WEINSCHEL ENGINEERING, 10503 Metropolitan Ave., Kensington, Md. Model 64 is a precision step attenuator designed for d-c to 1,000 mc. Impedance is 50 ohms from 0 to 64 db in 0.1-db steps. Maximum vswr from d-c to 400 mc is 1.10; from d-c to 1,000 mc, 1.15. Accuracy of insertion loss at d-c from 1 to 5 db is 0.02 db;

Westinghouse Silicon Rectifier WN-5082 with *maximum peak inverse voltage* ratings of 50-400 v. (300 to 5000 amperes in bridge assemblies.)



Westinghouse Type RA Single Operator D-C Arc Welder

Silicon (SI) Rectifiers win in grueling use tests

THE PROBLEM: Use six (6) Westinghouse 5082 diodes in a 3-phase full-wave bridge for an arc welder—the most rugged, most challenging application that can be found. See how they stand up under this rigorous duty cycle, high short-circuit peaks, alternate heating and cooling, and transient voltage spikes. *Compare the performance with other types of rectifiers.*

THE PERFORMANCE: Hundreds of these arc welders are today successfully performing for satisfied customers. Over 100,000 grueling duty cycles in industrial use have proved the value of Westinghouse Semiconductor Department's High Power Laboratory where this application was pretested round-the-clock with 35,000 duty cycles.

THE CONCLUSION: Westinghouse Silicon Rectifiers provide important advantages to builders and specifiers of rectifier assemblies . . . improve equipment design and operational efficiency with:

- More power in less space
- Higher temperature operation
- Lowered installation costs
- Unlimited life span
- Minimum maintenance expense
- Reduced power loss

Get the facts first hand!

The coupon will bring you complete engineering experience . . . suggested circuits . . . positive proof of new reliability, efficiency and economy.

YOU CAN BE SURE...IF IT'S

Westinghouse

WESTINGHOUSE ELECTRIC CORPORATION
P. O. Box 868, Pittsburgh 30, Pa.

Please send me data on the new Westinghouse WN-5082 Silicon Diode.

Please send me data on other Westinghouse Silicon Diodes. (Describe types or applications) _____

_____

_____

Name _____

Title _____ **Firm** _____

Address _____

City _____ **Zone** _____ **State** _____

Want more information? Use post card on last page.

FIGHT VIBRATION WITH VIBRATION

How many jobs can a vibration exciter do?

SHAKER SYSTEMS can help you in *at least* five important ways.

Fatigue testing. Shakers have both the range and capacity to determine fatigue limits of structural members, assemblies, aircraft wing and tail structures. Peak forces of up to 25,000 pounds are now obtainable with MB Exciter Systems.

Environmental vibration testing to MIL-E-5272 and other government specifications. This is most important now for assuring reliability of performance in military production. But the same techniques can be used also to improve *all* types of products.

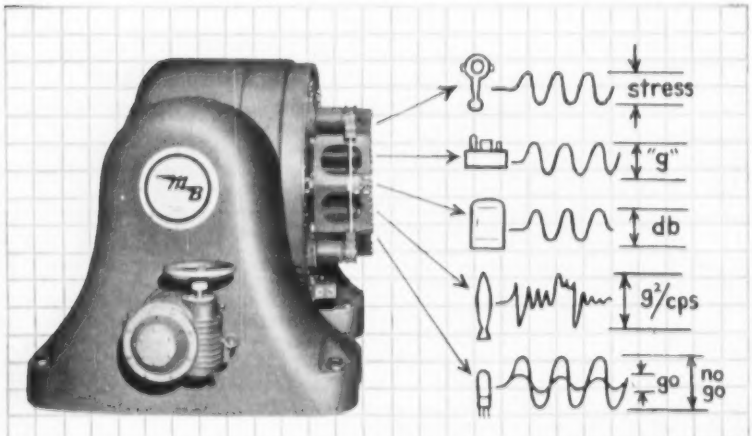
Noise. Just where in a product does it come from and how to eliminate it? An MB shaker helps pinpoint the disturbance by letting you vibrate the product through a whole range of frequencies with the twist of a dial.

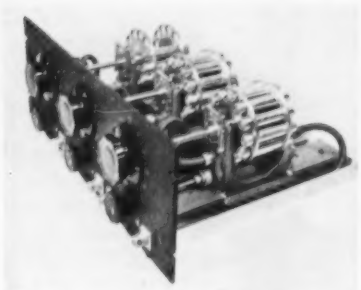
Complex wave testing, including random motions. This is something *new!* It subjects a specimen to the same kind of vibration as that encountered in actual service. MB electrodynamic shaker systems offer the frequency range, high acceleration, and freedom from distortion needed for this kind of job.

Production and Quality Control. *Your* ideas are needed here. For example: Someone discovered that size of fine powder particles which sift readily through a screen varies with the screen's frequency of vibration. Permitting easy control of frequency, an MB shaker is capable of working on a *production* line! Tubes too are being production-tested with MB Exciters.

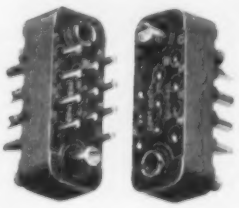
If you need help in putting vibration exciters to work, get in touch with MB . . . leading producer of vibration test equipment.

MB *manufacturing company*
A DIVISION OF TEXTRON INC.
1075 State Street, New Haven 11, Conn.
HEADQUARTERS FOR PRODUCTS TO ISOLATE . . . EXCITE . . . AND MEASURE VIBRATION





from 6 to 10 db, 0.05 db; from 20 to 50 db, 0.1 db. Maximum change of incremental insertion loss from 1 to 10 db is 0.1 db; from 20 to 50 db, 0.1 db per 10 db. Calibration accuracy from 1 to 30 db is ±0.1 db; from 40 to 50 db, ±0.2 db. Price is $1,950. **Circle P26 inside back cover.**



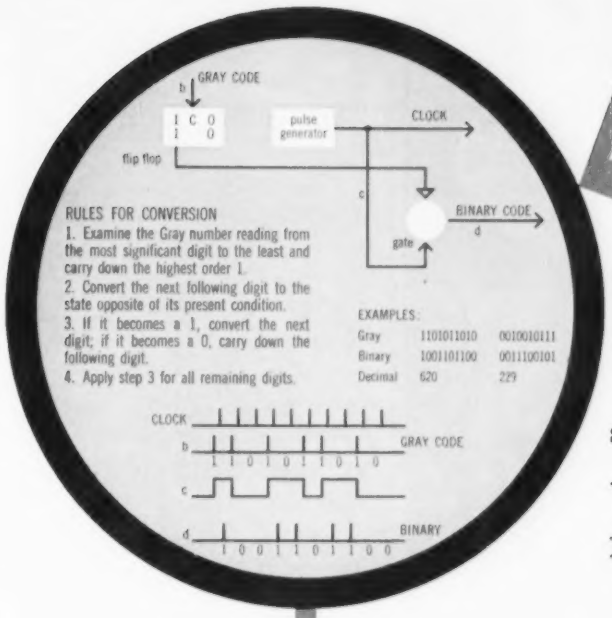
LITTLE CONNECTORS
for aircraft-type uses

DEJUR-AMSCO CORP., 45-01 Northern Blvd., Long Island City 1, N. Y. Series 22 precision Continental connectors are suited for applications where space is at a premium, as in aircraft and instrumentation. The 11-contact series 22 connector illustrated has an overall length of 0.78 in.; width 0.27 in.; center-to-center mounting dimensions on mounting studs, 0.532 in.

Polarization is assured with a reversed guide pin and guide socket made of stainless steel. Floating contacts insure positive self-alignment of each contact. The precision machined phosphor bronze contacts are gold plated over silver for low contact resistance and soldering ease.

Microminiature series is available in 7, 11, 14, 20, 26, 29 and 34 contacts, with or without aluminum hoods.

Complete information, specifi-


GRAY CODE
b
1 C 0
1 0
pulse generator
CLOCK
flip flop
c
BINARY CODE
d
gate
RULES FOR CONVERSION
1. Examine the Gray number reading from the most significant digit to the least and carry down the highest order 1.
2. Convert the next following digit to the state opposite of its present condition.
3. If it becomes a 1, convert the next digit; if it becomes a 0, carry down the following digit.
4. Apply step 3 for all remaining digits.
EXAMPLES:
Gray 1101011010 0010010111
Binary 1001101100 0011100101
Decimal 620 229
CLOCK
b
GRAY CODE
1 1 0 1 0 1 1 0 1 0
c
d
BINARY
1 0 0 1 1 0 1 1 0 0

solving logical problems with Burroughs pulse control systems

converting Gray code to binary equivalents

Here is a simple method for converting Gray code to true binary equivalents. It was put into operation in minutes just by interconnecting Burroughs Pulse Control Units in accordance with the engineer's block diagram, without detailed specifications or complicated circuit designs. With pulse control equipment at his disposal, the engineer was able to turn immediately to other important problems awaiting his attention.

The majority of engineers solving logical problems are badly in need of such tools. Most are bogged down by equipment of limited use that must be redesigned and rebuilt for every new project . . . that clutters the path to a working solution instead of clearing and shortening it.

The smallest discrete units with which such a man can work are logical concepts . . . the basic logical operations. The ideal tools for him are these same operations, packaged for convenient and immediate use by simple interconnections—like the blocks in his block diagram. Such tools are Burroughs Pulse Control Units, which bring block diagrams to life in a matter of hours rather than weeks. Wherever logical problems are being solved with pulses they have earned the title "Tools For Engineers" by eliminating intermediate steps to a proof, obsoleting the frustrations and complexities of breadboarding.

Why not lift the burden of proof from your shoulders by passing pulse problems on to us? We'll gladly show you how Burroughs Pulse Control Units can bring your logical problems closer to a neat working solution . . . at no cost. Or, write for Bulletin 236.

TOOLS FOR ENGINEERS

Burroughs

BURROUGHS CORP. • ELECTRONIC INSTRUMENTS DIV.
Department C • 1209 Vine Street • Philadelphia 7, Penna.

she'll have the precision high alumina ceramic parts for developing your projects in your hands tomorrow

NOW OFF-THE-SHELF-SERVICE
PROVIDES SAME-DAY SHIPMENT OF
precision DIAMONITE
HIGH ALUMINA CERAMIC RINGS, TUBES RODS

You no longer have to wait months while enthusiasm cools for the high alumina ceramic parts to build the pilot and test models of your projects.

Thanks to Diamonite's unique Off-the-Shelf Service with its large, constantly maintained inventories of hundreds of precision high alumina rings, tubes and rods, your small quantity requirements of such items can be at the airport and on their way to you in a matter of hours after your order is received.

Wherever it is possible to design your projects around these instantly-available shapes, you can not only save weeks of development time but will also be in a position to enjoy better deliveries, better costs and better quality when you are ready to go into production.

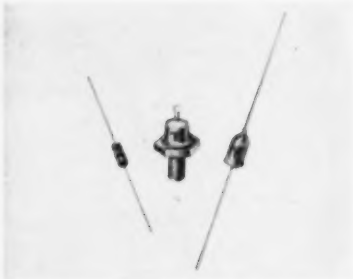
Write or Wire for a copy of the Diamonite Off-the-Shelf Inventory and Price List. You'll find it a helpful guide to your planning for getting your product to market quicker.

Save Months on Engineered Shapes, too

Diamonite's complete, modern pilot plant can produce small lots of most intricate ceramic shapes for development work in a matter of weeks. Airmail your prints and specifications for prices and deliveries.

DIAMONITE
products manufacturing company
pioneers in the development of high alumina ceramics
Canton 3, Ohio

cations and diagrams are available. **Circle P27 inside back cover.**



VOLTAGE REGULATORS
three new series

TRANSITRON ELECTRONIC CORP., Melrose 76, Mass., has available three new series of silicon voltage regulators designed to satisfy a full range of power requirements. They are available with ratings of 250 mw, 75 mw, 10 w and are encapsulated in small hermetically sealed axial mounting packages. All classes have standard types covering the voltage range 4.3 to 27 v. Close tolerance and higher voltage regulators are available in assemblies.

Specifications, ratings and applications are found in bulletin TE-1352. **Circle P28 inside back cover.**

ULTRASONIC GENERATOR
for research laboratories

RADIONICS, INC., Burlington, Mass. Model PUG3 is a research-grade instrument designed to deliver closely controlled r-f power to quartz-plate transducers in medical, industrial or academic re-

AT Thompson Products

THE DECISION IS PRECISION . . .

AND THE DECISION WAS PACE

Another example of major industry breaking through the problem barrier:

The New Device Research Department, a privately owned laboratory of Thompson Products, Inc., recently placed in operation one of the country's largest analog computing systems devoted to the solution of aeronautical control and nuclear control problems.

This PACE Computing System developed by Electronic Associates, Inc. will also be applied to industrial control problems.

The combination of non-linear and linear computing equipment enables wide-range simulation of electrical, mechanical, and pneumatic systems to be accomplished.

In research and simulation as vital as those at Thompson Products, the major decision is precision. And the high standard of accuracy of EAI Equipment sets the PACE for precision in the industry.

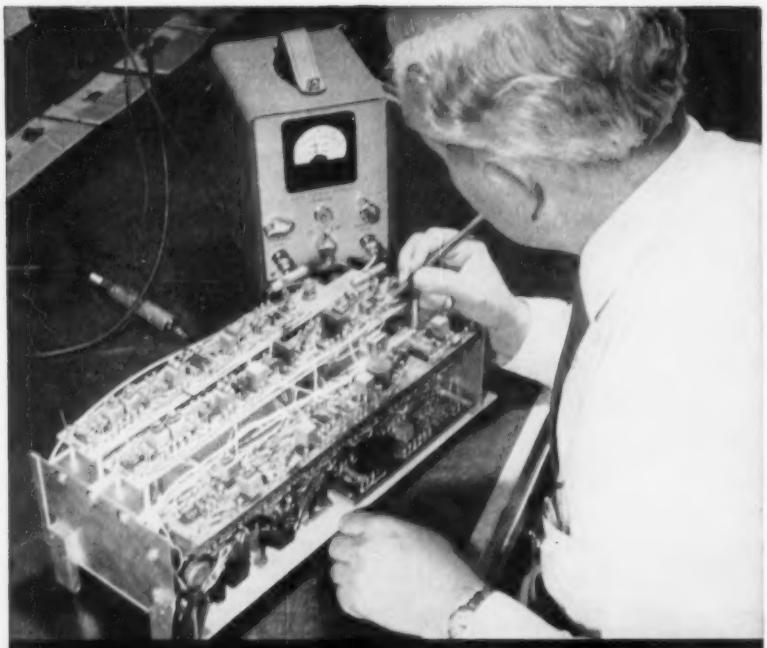
For a demonstration or for rental of time, contact our Computation Centers. There's a Center serving Eastern Industry in Princeton, N. J.—one serving Western Industry in Los Angeles, Calif. For equipment information, write Electronic Associates, Inc., Long Branch, N. J., Dept. EL-5.

ELECTRONIC ASSOCIATES Incorporated

EAI SETS THE PACE

P PRECISION A ANALOG C COMPUTING E EQUIPMENT ®

LONG BRANCH • NEW JERSEY



WITHOUT A TUBE

Here's the first step toward lifetime reliability in electronic gear — the conversion from vacuum tubes to rugged, lightweight, small size Berkeley FERRISTORS*.

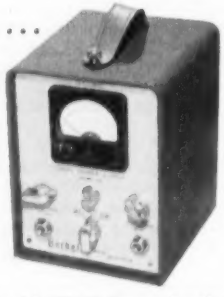
Berkeley FERRISTORS* consist of simple wire-wound coils on a ferro-magnetic core, encapsulated in epoxy resin. Costing less than comparable vacuum tubes, they offer these advantages:

1. **Continuous-duty reliability**
2. **Unaffected by vibration, shock, high overloads, humidity changes, temperature extremes**
3. **Total weight only ½ ounce; small as a cube of sugar**

TYPICAL APPLICATIONS

FERRISTORS* are now used as oscillators, multi-vibrators, bi-stable elements, one-shots and various linear amplifiers including coincidence amplifiers, balanced amplifiers and differential amplifiers.

Why wait for your competitor to use FERRISTORS* and offer electronic gear with lifetime reliability? Investigate **now** and beat him to the punch — write for Data File 110, "Electronic Design with FERRISTORS*." Please address Dept.G5



Model 470 RF Power Supply has dual outputs to supply 1.7 mc to drive up to 4 ring-of-10 bi-stable elements and to supply 10 mc to power at least 10 linear amplifiers. Ideal for preliminary investigations of circuits using the Berkeley FERRISTOR*. Price $95.00 f.o.b. factory.

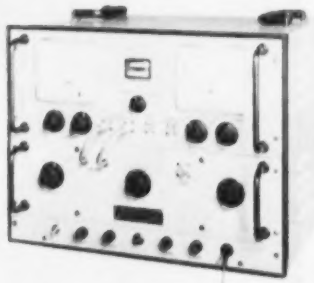
120

Beckman* / **Berkeley** *Division*
Richmond 3, California
a division of Beckman Instruments, Inc

*Trademark

search laboratories. Frequency range is 700 kc to 6 mc and power is available at odd harmonics of the fundamental frequency of the transducer crystal. The r-f crystal driving voltage is variable from zero to 3,000 v rms. With suitable transducers, (quartz only) outputs of 150 acoustic watts are available, either c-w or pulsed. Calibration stability is a primary consideration and extensive means are provided for presetting the controls so that any prescribed intensity level may be established.

Pulse duration is 0.005 to 2.0 sec in precise steps, up to 90 percent duty; pulse period, 0.1 to 10.9 sec, in 0.1-sec steps. Preset pulse count is 1 to 99,999; crystal vtvm, (four ranges)—100, 300, 1,000, 3,000 v. **Circle P29 inside back cover.**

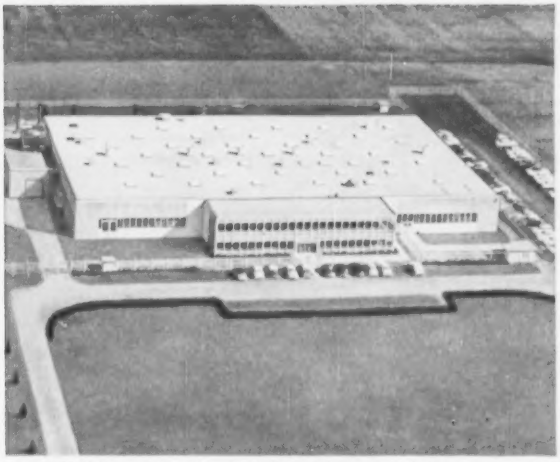


STABILITY TESTER
takes microwave readings

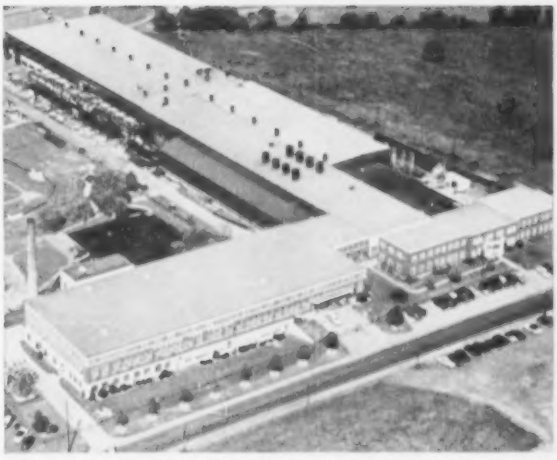
LABORATORY FOR ELECTRONICS, INC., 75 Pitts St., Boston 14, Mass. Changes in the frequency of microwave oscillators can be measured to a new high degree of precision with the model 5004 microwave stability tester. At S-band the change that can be indicated is less than 2 cps.

The instrument measures the drift and rate of drift of oscillators and, for this reason, it has many applications where the determination of stability is important. It is adaptable to take readings at S, L, C or X-band. Stability measurements may be taken at 30 mc and from 30 kc to 230 kc.

An important feature of the instrument is that readings can be taken instantaneously and monitored continuously. The device is



New 65,000 sq. ft. plant at Wapakoneta, Ohio. Completely modern in every respect. Close to the Mid-U.S. electronics industry.



Main plant at Norristown, Pa. Where most of the cathodes used in this country for more than 20 years have been made.

Two Modern Plants

FOR SEAMLESS NICKEL CATHODES

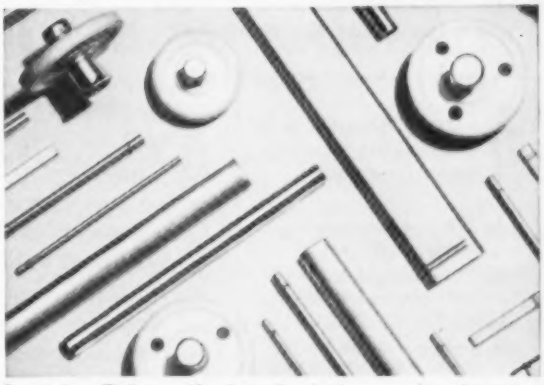
OFFER YOU DOUBLE DELIVERY ASSURANCE

Just like a second source of supply for every cathode order you place—without the inconvenience of dealing with two suppliers or worrying about product uniformity.

Each of these two big Superior Tube cathode plants follows exactly the same manufacturing methods and quality control procedures. Each employs the same laboratory checks on materials and finished cathodes. So cathodes can be produced at either plant and exactly meet the specifications.

Now there's more reason than ever to make Superior Tube your regular source for electron tube cathodes. Get complete technical information in the new Catalog 51. Write Superior Tube Co., 2500 Germantown Ave., Norristown, Pa.

*Manufactured under U. S. patents



Superior Tube cathodes. Typical examples. Seamless, Lockseam,* and Weldrawn® cathode sleeves are available in a wide variety of lengths and cross-section shapes. New CATHALOY® cathode materials offer new properties and superior performance.

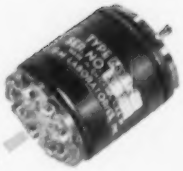
Superior Tube

The big name in small tubing

NORRISTOWN, PA.

Johnson & Hoffman Mfg. Corp., Mineola, N.Y.—an affiliated company making precision metal stampings and deep-drawn parts

Shake well



BEFORE USING!

Vibration . . . with frequencies up to 500 cycles per second and up to 15 G's . . . might prove to be a shattering experience for some servo motors. But *not* for a G-M Servo!

4 GOOD REASONS WHY G-M SERVO MOTORS SERVE YOU BEST!

1. G-M servo motors are available in standard sizes.
2. G-M servo motors can be modified to meet specific circuit requirements.
3. Creative engineering in designing special servo motors with special characteristics.
4. Fast production—better service.

This vibration test at G-M is only one of a series of environmental tests all G-M servo motors must successfully pass—before they can be integrated into your control system.

G-M precision-built servo motors conform to all military environmental specifications when so specified. They are designed to perform under the toughest humidity, salt spray, temperature, altitude and vibration conditions . . . and they come back for more!

Write Now

for information, or send for complete G-M charts and specifications. No obligation, of course.

GM

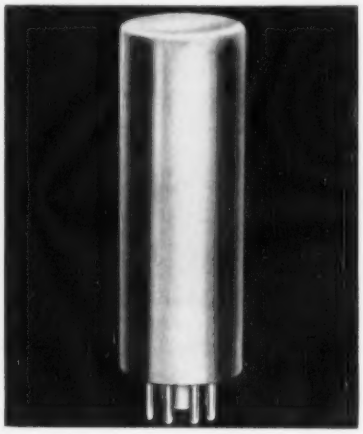
G-M Servo Motors

manufactured by the Components Division of

G-M LABORATORIES INC.

4336 N. Knox Avenue • Chicago 41

a laboratory type instrument of semimilitary construction. **Circle P30 inside back cover.**



CRYSTAL & OVEN PACKAGE

for 4 kc to 125 mc

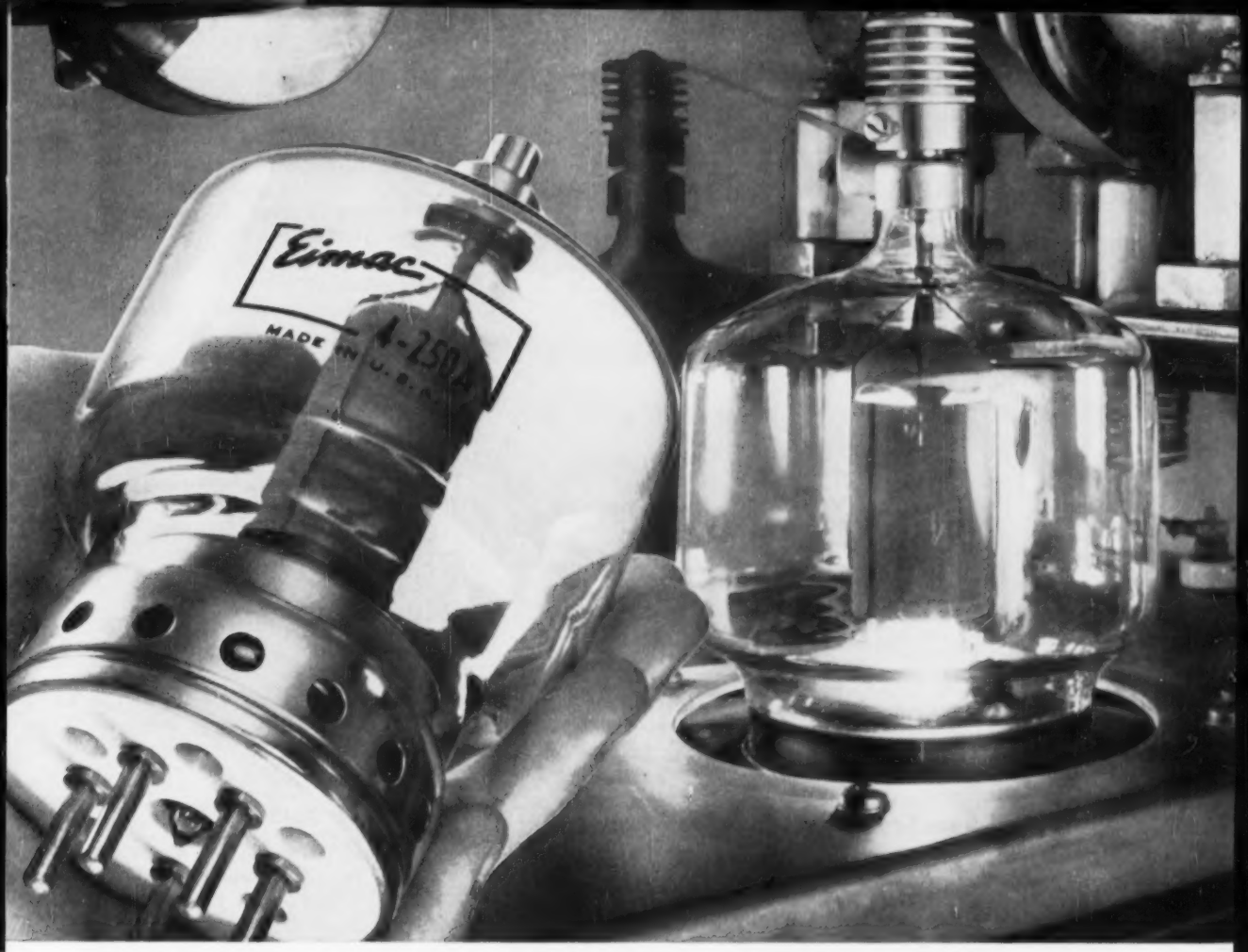
BLILEY ELECTRIC CO., Union Station Bldg., Erie, Pa. The BTC-2 is a crystal and oven package. Combined into a single hermetically sealed plug-in unit is an all-glass vacuum mounted crystal, plus integral temperature stabilizers for high-precision frequency control at 75C or 85C. High reliability over the frequency range of 4 kc to 125 mc is assured. Request bulletin No. 497. **Circle P31 inside back cover.**

SUBMINIATURE RELAY

for high precision work

ELGIN NATIONAL WATCH CO., Elgin, Ill., has announced a new high precision subminiature relay in the popular crystal can size. Designed to meet the most severe military specifications, the new relay will be marketed under the code name MV and will be available with both solder-lug and plug-in terminals.

It is a rotary action dpdt relay



22,000 hours without a tube failure

Eitel-McCullough
San Bruno, Calif.
Gentlemen:

"Just thought you might like to know that I have had to replace one of your 4-250A's in our FM transmitter today. This tube had 21,972 hours and 19 minutes on it. Its mate, installed at the same time, is still running strong."*

Ed Howell
Technical Supervisor
WMIX, Mount Vernon, Illinois

*Its mate, from recent reports, is still running strong after *25,000* hours of service.

Eimac tubes have always been "front runners" in the field of commercial broadcasting. In fact, Eimac development, design and production, have opened new vistas in all fields of electronic design, from glass tubes to ceramics—from simple triodes to complex klystrons. Engineers, in increasing numbers, have discovered that Eimac delivers the big three: quality—longevity—performance!

Additional information on Eimac's complete line of tubes for broadcasting and communications is available from our Application Engineering Department.

EITEL-McCULLOUGH, INC.
SAN BRUNO CALIFORNIA
Eimac First **with power for FM**

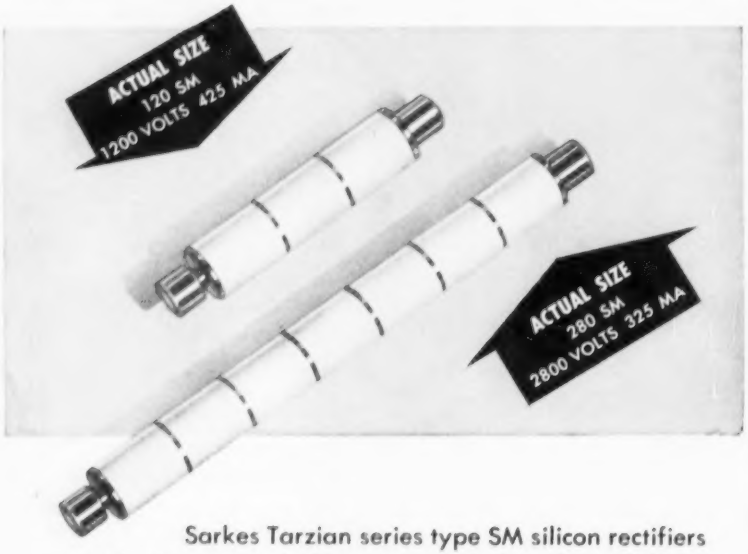
Eimac

EIMAC 4-250A
Class—C FM
(Frequencies below 110MC)

D-C Plate Voltage	4000 volts	Grid Dissipation	0.46 watts
D-C Screen Voltage	500 volts	Peak R.F. Grid Input Voltage	approx. 303 volts
D-C Grid Voltage	−225 volts	Driving Power	approx. 2.46 watts
D-C Plate Current	312 ma	Plate Power Input	1250 watts
D-C Screen Current	45 ma	Plate Dissipation	250 watts
D-C Grid Current	9 ma	Plate Power Output	1000 watts
Screen Dissipation	22.5 watts		

Your Demands Created

HIGH VOLTAGE
SILICON POWER RECTIFIERS



Sarkes Tarzian series type SM silicon rectifiers provide the practical, low cost solution to the high voltage silicon rectifier problem. Stable characteristics inherent in low voltage junctions are carried over to this series. If your application calls for high temperature and high voltage, send for complete information.

ELECTRICAL RATINGS

S T Type	Max Peak Inverse Volts	Max RMS Volts	Current Ratings—Amperes: Max. D.C. Load 100°C	Max. D.C. Load 150°C	Max. RMS 100°C	Max. RMS 150°C	Max. Recurrent Peak 100°C	Max. Recurrent Peak 150°C	Surge 4MS Max. 100°C	Surge 4MS Max. 150°C	Jetec No.
80SM	800	560	450	225	1.12	.560	4.5	2.25	27.0	13.5	1N1108
120SM	1200	840	425	212	1.06	.530	4.25	2.12	25.5	12.7	1N1109
160SM	1600	1120	40	200	1.00	.500	4.00	2.00	24.0	12.0	1N1110
200SM	2000	1400	375	187	.940	.470	3.75	1.87	22.5	11.2	1N1111
240SM	2400	1680	35	175	.875	.437	3.50	1.75	21.0	10.5	1N1112
280SM	2800	1960	325	162	.812	.405	3.25	1.62	19.5	9.7	1N1113

DIMENSIONS

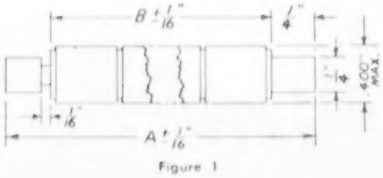


Figure 1

Figure 1 A	Figure 1 B	JETEC NO.
1-15/32"	31/32"	1N1108
1-15/16"	1-7/16"	1N1109
2-13/32"	1-29/32"	1N1110
2-7/8"	2-3/8"	1N1111
3-11/32"	2-27/32"	1N1112
3-13/16"	3-5/16"	1N1113

Sarkes Tarzian INC.

RECTIFIER DIVISION

415 N. College Ave., Dept. D-1, Bloomington, Ind

IN CANADA: 700 WESTON RD., TORONTO 9, TEL. ROGERS 2-7535
EXPORT: AD AURIEMA, INC., NEW YORK CITY

designed to operate in a temperature range of up to +125 C with a contact rating at 2 amperes resistive at 28 v d-c or 115 v a-c. Vibration is rated at 10 to 80 cps at maximum excursion of 0.06 in. and from 80 to 2,000 cps at 20-g acceleration.

The relay is slightly less than an inch long by ¾ in. wide and ¼ in. thick. It weighs only 0.44 oz. **Circle P32 inside back cover.**

VTVM
priced at $145

GENERAL RADIO CO., 275 Massachusetts Ave., Cambridge 39, Mass. Type 1800-B vtvm has an accuracy better than ±2 percent on all a-c and d-c voltage ranges. Its completely shielded diode probe is designed for use into the uhf range. Other features include a high input impedance, d-c polarity switch, illuminated meter scale with mirror and knife-edge pointer. All input terminals are insulated from the panel allowing the panel to be grounded at all times.

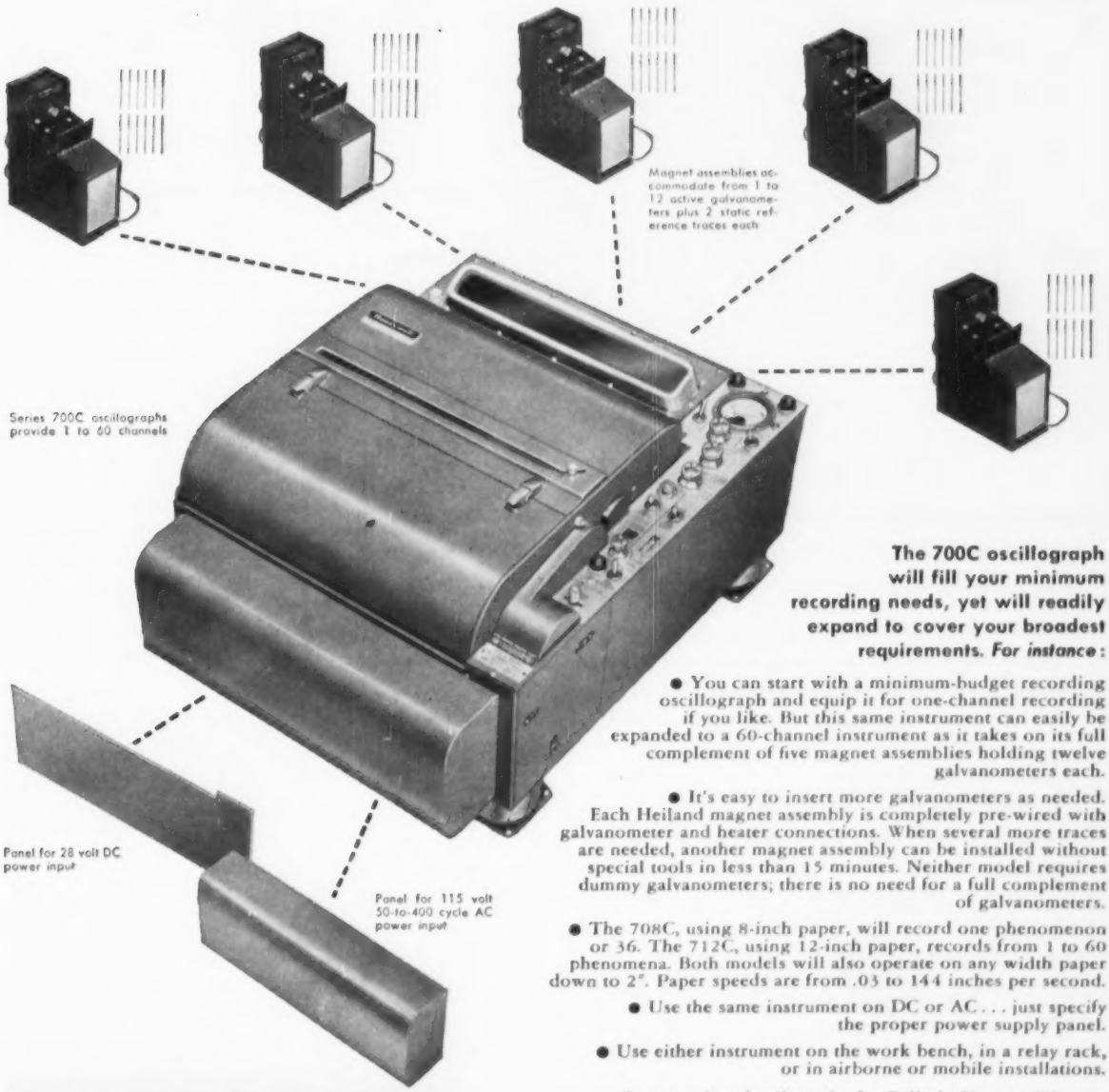
Stability has been achieved through advanced circuit design, power-supply regulation and the use of long-term stable precision components. Price of the unit is $415. **Circle P33 inside back cover.**

DETECTOR METER
shows up interference

INTERFERENCE TESTING AND RESEARCH LABORATORY, INC., 150 Causeway St., Boston 14, Mass. Model 2A interference detector meter has been developed for the purpose of quickly and simply detecting the presence of inter-

expand your oscillograph capacity as your needs demand...

with the HEILAND Series 700C Recording Oscillograph


Magnet assemblies accommodate from 1 to 12 active galvanometers plus 2 static reference traces each
Series 700C oscillographs provide 1 to 60 channels
Panel for 28 volt DC power input
Panel for 115 volt 50-to-400 cycle AC power input

The 700C oscillograph will fill your minimum recording needs, yet will readily expand to cover your broadest requirements. *For instance:*

- You can start with a minimum-budget recording oscillograph and equip it for one-channel recording if you like. But this same instrument can easily be expanded to a 60-channel instrument as it takes on its full complement of five magnet assemblies holding twelve galvanometers each.
- It's easy to insert more galvanometers as needed. Each Heiland magnet assembly is completely pre-wired with galvanometer and heater connections. When several more traces are needed, another magnet assembly can be installed without special tools in less than 15 minutes. Neither model requires dummy galvanometers; there is no need for a full complement of galvanometers.
- The 708C, using 8-inch paper, will record one phenomenon or 36. The 712C, using 12-inch paper, records from 1 to 60 phenomena. Both models will also operate on any width paper down to 2". Paper speeds are from .03 to 144 inches per second.
- Use the same instrument on DC or AC . . . just specify the proper power supply panel.
- Use either instrument on the work bench, in a relay rack, or in airborne or mobile installations.

For complete details, write for Bulletin No. 700-EK

MINNEAPOLIS **Honeywell**

Heiland INSTRUMENTS

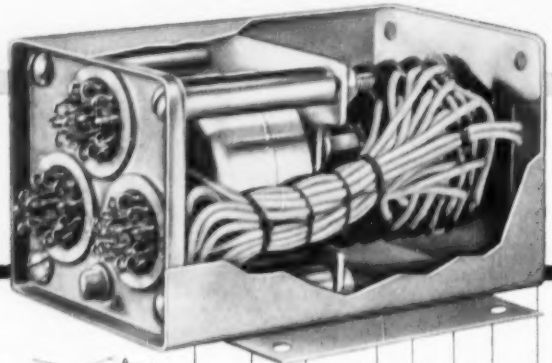
5200 E. EVANS AVE., DENVER 22, COLORADO

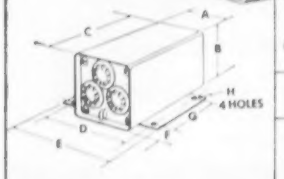
SALES—SERVICE FACILITIES AROUND THE WORLD

Want more information? Use post card on last page.

NEW LEDEX

HERMETICALLY SEALED ROTARY SELECTOR SWITCHES AND STEPPING RELAYS





MODEL	MAX. NO. WAFERS	MAX. NO. HEADER PINS	A	B	C	D	E	F	G	H
No. 4	4	45*	2¼"	2⅝"	4½"	2¹⁵⁄₁₆"	3⅛"	¾"	3"	5⁄16"
No. 5	4	105*	3⅜"	3⅜"	5⅞"	4⅝"	4¾"	2³⁄₃₂"	4"	5⁄16"

*Circuits should allow for header pins to carry arc suppression items externally

THESE STANDARD HERMETICALLY SEALED ENCLOSURES ARE NOW AVAILABLE FOR LEDEX

Hermetically sealed Ledex switches are moisture-proof, dust-proof and protected from the effects of salt-spray, fungus and humidity. Also, many of the hermetically sealed Ledex selectors qualify for the requirements of MIL-E-5272A. Ledex selectors simplify installation problems, reduce wiring time to a minimum and prevent damage caused by tampering.

Many switching combinations are available with the standard models. If the standard models do not answer your specific requirements, send the salient facts of your special hermetically sealed selector switch problem to us for our recommendations.

For best delivery specify one, ten or fifteen pin headers. (Illustrated)

G. H. Leland INC.

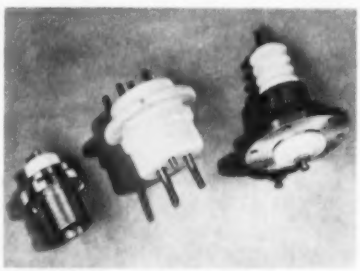
WRITE FOR COMPLETE INFORMATION TODAY!

123 WEBSTER STREET, DAYTON 2, OHIO

IN CANADA: MARSLAND ENGINEERING LTD., KITCHENER, ONTARIO
IN EUROPE: NSF LTD., 31-32 ALFRED PLACE, LONDON, ENGLAND

ference within electronic and electrical equipment and on secondary power lines. It will detect interference, between 0.075 mc and 35 mc, of sufficiently high intensity to cause malfunctioning of critical equipment, or to be a potential cause of malfunctioning. It may be used on production lines to compare the order of intensity of interference given off by samples of the same type and thus serve as a means of quality control.

By the use of broadband-conducted techniques of measurement, is can be used in high ambient level areas where screen rooms would otherwise be required. An antenna is available, as an accessory, to make radiated tests of interference with an intensity of 1 mv or more. Price is $250 with one accessory. **Circle P34 inside back cover.**



INSULATING CONNECTORS
for h-f coax service

JOCLIN MFG. CO., North Haven, Conn., has developed a new idea in insulating connectors for h-f coaxial service in radio, radar and other electronic equipment. Connectors are available with an insulation material that is nonflammable, will not carbonize under

NEW

DC-to-10 MC 3-INCH OSCILLOSCOPE

Type 316 PORTABLE

This interesting new instrument combines a dc-to-10 mc passband, high sensitivity and wide sweep range in a handsome container that weighs only 35 pounds and measures only 8½" wide, 12" high and 19½" deep. It offers marked improvements in performance, reliability and accessibility over the popular Type 315D, which it replaces in the Tektronix oscilloscope family.

In spite of its small size, the Type 316 is an excellent laboratory oscilloscope. Compactness can be advantageous there, as well as out in the field. It's as rugged as a light-weight oscilloscope of high precision can be, able to take much more than the normal field environment without a pause in its accurate operation.

ENGINEERS—interested in furthering the advancement of the oscilloscope? We have openings for men with creative design ability. Please write Richard Rapiequet, Vice President, Engineering.

TYPE 316 SPECIFICATIONS

VERTICAL AMPLIFIER

Deflection Characteristics—12 calibrated steps from 0.01 v/div to 50 v/div.
2 cycles to 9 mc—0.01, 0.02 and 0.05 v/div.
dc to 10 mc—0.1, 0.2, 0.5, 1, 2, 5, 10, 20 and 50 v/div.
Continuously variable from 0.01 v/div to 125 v/div.

Transient Response—0.035-μsec rise-time from 0.1 to 125 v/div, 0.04-μsec from 0.01 to 0.1 v/div.

Signal Delay—balanced 0.25-μsec delay network.

TIME BASE

Sweep Range—22 calibrated steps from 0.2 μsec/div to 2 sec/div, continuously variable from 0.2 μsec/div to 6 sec/div.

Magnifier—accurate 5x magnification, increasing calibrated sweep range to 0.04 μsec/div.

Triggering—internal, external, line—ac or dc coupled, automatic triggering and high-frequency sync. PRESET or MANUAL stability control for all triggering modes.

OTHER FEATURES

1.85-KV Accelerating Potential—new Tektronix precision 3" cathode-ray tube provides 8-div by 10-div linear viewing area.

Square-Wave Voltage Calibrator—0.05 v to 100 v in 11 steps, frequency about 1 kc.

Electronically-Regulated Power Supplies

Warning Indicators for Uncalibrated Settings

Size—8½" wide, 12" high, 19⅛" overall depth.

Weight—35 pounds.

Type 316 (50 to 60 cycle supply).....**$725**

Type 316-S1 (50 to 800 cycle supply)....**$760**

Prices f.o.b. Portland, Oregon

Tektronix, Inc.

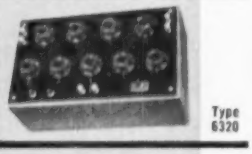
P. O. Box 831 • Portland 7, Oregon

Phone CYpress 2-2611 • TWX-PD 265 • Cable: TEKTRONIX

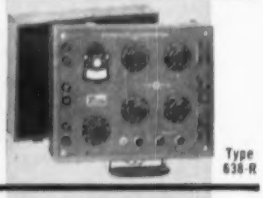
Want more information? Use post card on last page.

Shallcross BRIDGES

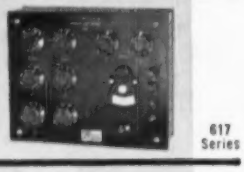
Types 6100 and 6101



Type 6320



Type 638-R



617 Series

Type 6350

ACCURATE dc RESISTANCE MEASUREMENTS

. . . 1 micro-ohm to 10^6 megohms

Among the many bridges manufactured by Shallcross, these six have become virtually "standards" for general-purpose resistance measurements. Each is easy to operate and ruggedly constructed to maintain accuracy and stability in every kind of field and laboratory service. Switch decks are inside the case for minimum maintenance.

Of special interest are the 617 Series Limit Bridges. These provide direct "GO-NO GO" production line resistor testing for any percent tolerance spread from ±0.1% to ±20%.

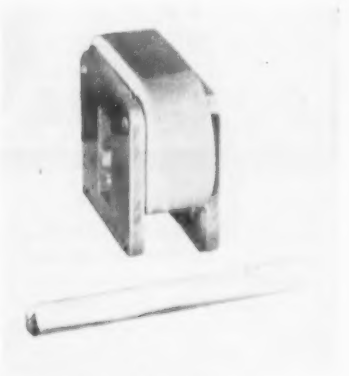
NEW BULLETIN L-19B contains full specifications for each instrument. For your copy write to: SHALLCROSS MANUFACTURING COMPANY, 522 Pusey Avenue, Collingdale, Pa.

Model Number	Measurement Accuracy	Maximum Setting	Minimum Setting	Circuit	Special Features
6100	±0.1% +0.01Ω (.1Ω to 1.011 MegΩ)	1.011 MegΩ	0.001Ω	Fault Location—Wheatstone	Fault Location by Murray, Varley, Hilborn & Fisher Loop Tests.
6101	±0.1% +0.01Ω (1Ω to 11.11 MegΩ)	11.11 MegΩ	0.001Ω	Wheatstone	Four dial rheostat usable as decade box.
6320	±0.02% +0.01Ω (1Ω to 11.11 MegΩ)	111.11 MegΩ	0.00001Ω	Wheatstone	Most accurate five dial Shallcross bridge for direct resistance measurement.
	±0.05% to ±20% on separate "+" and "—" percent selectors. (1Ω to 10 MegΩ)	11.111 MegΩ	0.0001Ω	Percent Limit	Rapid "GO-NO GO" percent limit testing. Built-in adjustable comparison standard.
638-R	±0.75% or better (.001Ω to 1Ω)	11.11Ω	0.000001Ω	Kelvin	Overlapping Kelvin and Wheatstone ranges selected with single ratio dial.
	±0.2% +0.01Ω (1Ω to 11.11 MegΩ)	11.11 MegΩ	.001Ω	Wheatstone	
6350	±1%, (10Ω to 10 MegΩ) ±2%, (10 MegΩ to 10,000 MegΩ) ±5%, (above 10,000 MegΩ)	1.111 x 10^9 MegΩ	0.01Ω	Wheatstone with d-c Amplifier	Modular construction dual range power supply, null indicator-amplifier, for 115V, 60 cycle operation.
617 Series	±0.1% to ±20% on separate "+" and "—" selectors from a minimum resistance consistent with number of dials in use to the maximum settings.	111,111Ω 1,111,110Ω 11,111,100Ω	0.1Ω *1Ω 10Ω	Percent Limit	For rapid "GO-NO GO" percent limit testing. Hand or foot operated for production testing. All models also usable for direct resistance measurements. Binding post for external d-c power supply.
	†±0.2% +0.01Ω from a minimum consistent with number of dials in use to the maximum setting.	111,111Ω 1,111,110Ω 11,111,100Ω	0.1Ω *1Ω 10Ω	Wheatstone	

† Except 617B and 617J ±0.1% ±0.01Ω. * Except 617G, 0.01Ω.

arcing, and is indestructible in the face of the roughest handling on assembly lines.

The insulating body is molded of Du Pont Teflon, a chemically inert compound with high dielectric strength that is serviceable at temperatures from −100 to +500 F. Simplicity of design and manufacturing is ideal for miniaturization work. **Circle P35 inside back cover.**



LOAD ISOLATOR
designed for microwave use

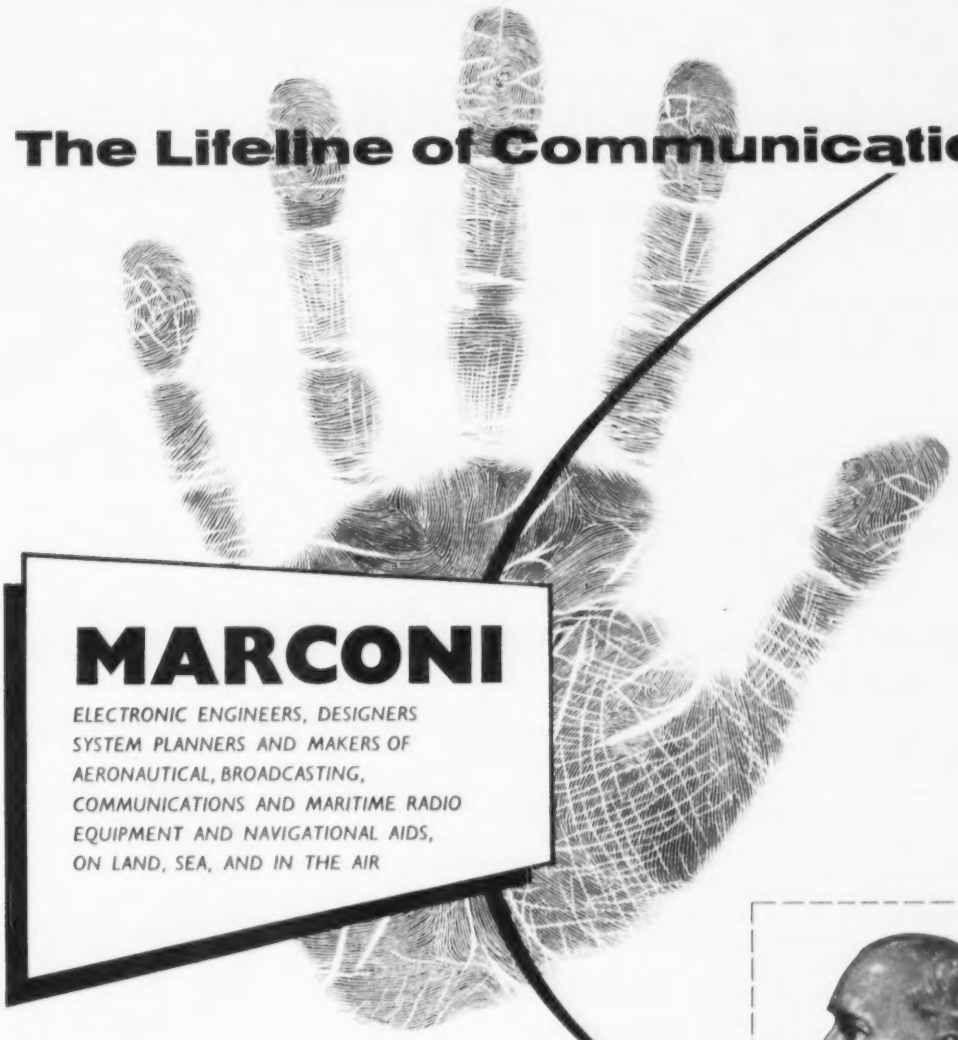
CASCADE RESEARCH CORP., 53 Victory Lane, Los Gatos, Calif. Model X-125 Uniline is a miniaturized ferrite microwave load isolator having a total length of only 1 in. and weight of only 9 oz. It operates over the frequency range of 8.5 to 9.6 kmc.

Isolation is 10.0 db over the band with an insertion loss of 1.0 db. Peak power is 100 kw, average power is 100 w into a 2-to-1 mismatch. The vswr is 1.15 into a matched load. Waveguide size is RG-52/U, flanges UG-39/U. **Circle P36 inside back cover.**

MICROWAVE TUBE
broadband amplifier type

RAYTHEON MFG. CO., Waltham 54, Mass. The Amplitron, a new high-power broadband microwave amplifier tube, operates without mechanical or electrical adjustments and may be used as the output stage of a high-power broadband chain. Its combined high-power, broadband and coherent operation are essential to advanced radar

The Lifeline of Communication



MARCONI

ELECTRONIC ENGINEERS, DESIGNERS
SYSTEM PLANNERS AND MAKERS OF
AERONAUTICAL, BROADCASTING,
COMMUNICATIONS AND MARITIME RADIO
EQUIPMENT AND NAVIGATIONAL AIDS,
ON LAND, SEA, AND IN THE AIR

MARCONI'S HAND IN THE HISTORY OF ELECTRONICS

In 1896, at the age of 22, Marconi demonstrated the 'wireless telegraph' equipment he had invented in his family home near Bologna to British Post Office and Forces chiefs. The initial possibilities of his enterprise were grasped. 'Radio' had arrived.

In 1897 a company, headed by him, now known as Marconi's Wireless Telegraph Company, Ltd., was founded in England to develop his ideas. Over the past 60 years that company has remained in the forefront of both the practical application of electronic principles and further pure research into them. It has been a pioneer in Radio and Radio/Telephone Communications, in Maritime Radio, Airborne and Airport Radio, Broadcasting and Television, Radio Aids to Navigation and Radar.

The achievements of the engineers and physicists whom Marconi gathered about him, and of their successors, have laid a foundation of unsurpassed experience on which to base future activities. A tradition of resourcefulness, enterprise, foresight and persistence characterises the Marconi Company today.

Information about the Marconi Company's latest equipment is available to American radio and electronic engineers for the asking.

The bust of Guglielmo Marconi unveiled in the Hall of Fame of the Institute of Electrical Engineers, by his daughter in October, 1955.

J. S. V. Walton, Marconi's Wireless Telegraph Company Limited, 23-25 Beaver Street, New York City 4.

Marconi's Wireless Telegraph Company Limited, Chelmsford, Essex, England.

LG 13

DO YOU HAVE A PRODUCTION PROBLEM?

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Stehedco *Quality* and Service

We are frequently called upon to develop and manufacture parts for the Electronics field. Typical of such a problem is our development of capacitor tab material of high quality aluminum with controlled tensile strength. Available in sizes to ¾" and from .0035" thick, it features rounded, burr-free edges and absolutely smooth surface, tightly wound on endless, non-telescoping coils to 3400 feet long.

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STEEL HEDDLE MFG. CO.
2100 WEST ALLEGHENY AVENUE • PHILADELPHIA 32, PA.
TELEPHONE SAGAMORE 2-2460

and countermeasures systems.

Practical applications include electronic scanning of radar beams without moving reflectors, rapid shifting of frequency to avoid r-f interference and coherent MTI systems. Specifications are available. **Circle P37 inside back cover.**

TRANSISTOR FURNACE
with high accuracy

BTU ENGINEERING CO., 440 Somerville Ave., Somerville 43, Mass., has announced a new type electric furnace specifically designed for alloying, brazing and soldering of transistors and other semiconductor products.

These Transheat furnaces feature: unique muffle design for controlled temperature profile; longlife heaters; controlled atmosphere and curtains; variable-speed drive; easily accessible parts; noncontaminable stainless steel belt. The temperature control system incorporates strategically located thermocouples for quick response, multiple temperature controlled zones for heating

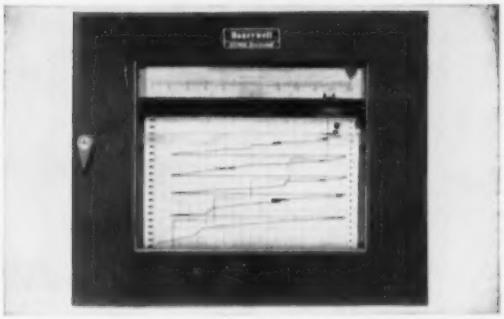
Speed completion *of your project...* with *ElectroniK* special span and range instruments

Eliminate much of the guesswork and bother of laboratory and test cell work with these *ElectroniK* special range and span instruments. They measure and record or indicate variables quickly, accurately, conveniently . . . are particularly valuable where precise evaluation and good resolution are needed.

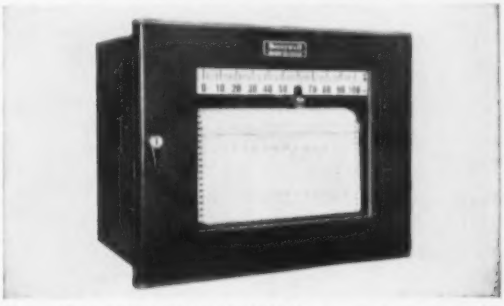
Your nearby Honeywell sales engineer will be glad to help you select and apply these and other *ElectroniK* instruments for research. Call him today . . . he's as near as your phone.

MINNEAPOLIS-HONEYWELL REGULATOR CO.,
Industrial Division, Wayne and Windrim Avenues,
Philadelphia 44, Pa.—in Canada,
Toronto 17, Ontario.

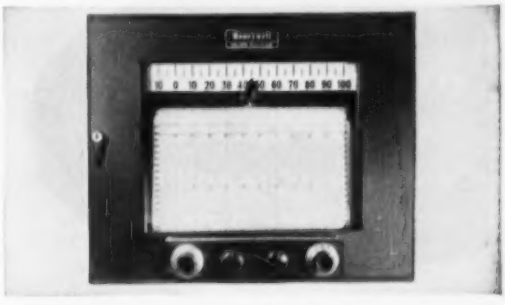
MINNEAPOLIS
Honeywell
BROWN INSTRUMENTS
First in Controls



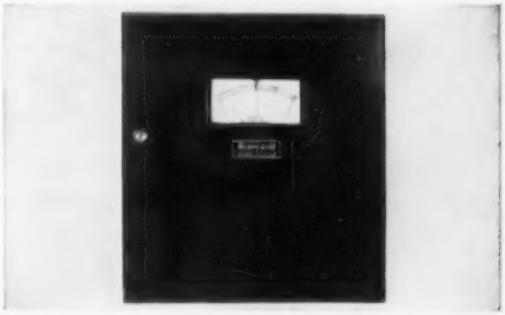
ElectroniK EXTENDED RANGE RECORDER—Simplifies measurement of any linear variable whose values change over a wide range. Particularly suitable to the measurement of forces in conjunction with a strain gage bridge. Typical application: Projectile stress testing in wind tunnels. *Write for Instrumentation Data Sheet 10.0-18.*



ElectroniK NARROW SPAN RECORDERS—Accurately measure d-c potentials as low as 0.1 microvolt and spans as narrow as 100 microvolts. Available as precision indicator, circular chart recorder, and strip chart recorder. For measuring differential temperatures and slight variations in temperatures of small objects through radiation pyrometry. *Write for Instrumentation Data Sheet 10.0-8.*



ElectroniK ADJUSTABLE SPAN RECORDER—Measures spans and magnitudes of a variety of emf's. Instrument calibration can be in terms of any variable reducible to d-c voltage. Can be used with thermocouples, steam gages, tachometers, and other transducers. *Write for Instrumentation Data Sheet 10.0-10a.*



ElectroniK EXTENDED RANGE INDICATOR—Incorporates extended scale and automatic range changing, serves in same applications as Extended Range Recorder. Resolution greater than one part in five thousand can be obtained, with use of a linear scale. As many as 10 ranges available. *Write for Instrumentation Data Sheet 10.0-3.*

Want more information? Use post card on last page.

MicroMatch

DIRECTIONAL COUPLERS

accurately monitor transmitter output

Built into major military communications and ballistic missile programs, MicroMatch Directional Couplers provide simple but precise means of continuously monitoring RF power and VSWR. Independent of frequency over a very wide range, these directional couplers are available for use at frequencies between 3 and 4000 megacycles.

These low-cost, compact units are adjusted to produce full scale meter deflection at power levels of 1.2 watts to 120 KW. Accuracy of power measurement is ± 5% of full scale. For positive confirmation of transmitter performance, make sure that MicroMatch Directional Couplers are built in.

WRITE FOR OUR 50-PAGE CATALOG—OR SEE PAGE 323 OF ELECTRONICS BUYERS GUIDE FOR MORE INFORMATION

WHEN MICROMATCH® IS BUILT IN—
YOU KNOW WHAT'S GOING OUT

*U. S. Patent Letters No. 2,588,390

M.C. Jones

M. C. JONES ELECTRONICS CO., Inc.
BRISTOL, CONNECTICUT

and cooling rates and self-balancing input controls that maintain temperatures to within ± 0.25 percent of full scale range. **Circle P38 inside back cover.**

FERRITE ISOLATOR
for lab and test bench

KEARFOTT CO., INC., 14844 Oxnard St., Van Nuys, Calif., announces a new ferrite isolator designed for maximum frequency stability and engineered to small size (2½ in. long, weighing only 1½ lb).

Illustrated is the model W177-2C-1 laboratory or test bench ferrite isolator for broad band, usable from 8.2 to 10.2 kmc. With high isolation, a minimum of 25 db over the band with less than 1-db insertion loss, the isolator is a highly stable instrument.

Made with cover-type flanges to mate with UG39/U flanges, it will absorb up to 10-w reflected power. **Circle P39 inside back cover.**

NULL DETECTOR
isolated from power lines

INDUSTRIAL TEST EQUIPMENT CO., 55 E. 11th St., New York 3, N. Y. Model 60B null detector is battery operated to provide complete isolation from power lines. It is well shielded against external fields

Which one of these Genisco centrifuges meets your requirements for testing components under simulated operational G-loadings?

...as required by Mil 5272A, procedure II

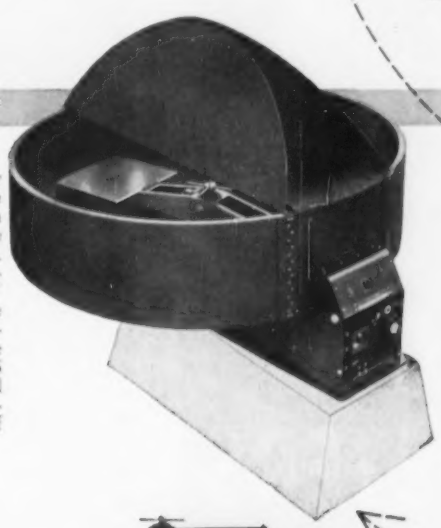
Genisco G-Accelerators provide a quick, precise means of testing components in an acceleration environment similar to that encountered in actual operation.

They are extremely accurate machines, easy to operate and built to withstand years of hard use.

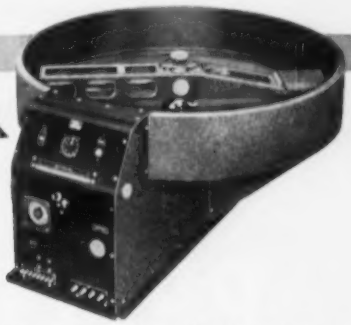
These features particularly suit them for large volume testing programs, as well as for precise laboratory prototype development.

More than 100 Genisco G-Accelerators of various capacities are now in use throughout the world.

Complete technical information on all models and accessories is available. Please direct your inquiry to: Contracts Manager, Genisco, Inc., 2233 Federal Avenue, Los Angeles 64, California.



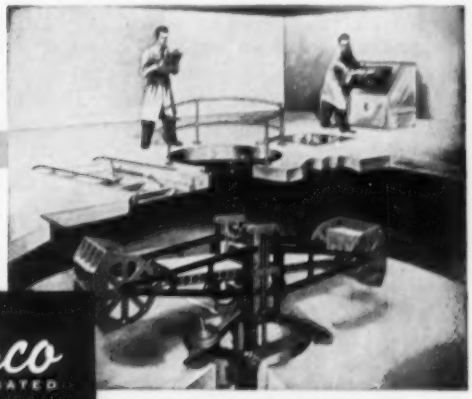
MODEL C159 The larger capacity of this machine permits whole system components and complete packages to be tested. Two objects, each weighing 100 pounds and 24" x 24" x 18" in size, can be accommodated simultaneously. G-range of the machine is 0.024 G to 75 G's. Maximum centrifugal capacity is 2000 G-pounds. Nominal radius of gyration 48".



MODEL B78 Used primarily for testing relays, switches, tubes, motors, valves, and other small components, and to calibrate and evaluate accelerometers. Accommodates objects weighing up to 25 lbs.; has G-range of 0.017 G to 120 G's. Maximum centrifugal capacity is 1200 G-pounds. Nominal radius of gyration 24".

MODEL D184 A high-speed machine, designed to test accelerometers and other instruments under acceleration forces from 1 to 850 G's. Full centrifugal capacity is 1000 G-pounds. Nominal radius of gyration 12".

MODEL E185 This newest and largest Genisco centrifuge was recently built for the U.S. Air Force. Two mechanical or electronic packages, each weighing up to 300 pounds, can be subjected to an acceleration environment of up to 65 G's simultaneously. Nominal radius of gyration of the machine is six feet. An automatic dynamic balancing system automatically compensates for any excessive unbalance in the machine during test runs.



ACCESSORIES ADD TO OPERATING EASE A number of accessories including a strobe system, air system, optical system, tub cover, access doorway, and slip ring systems, designed to give greater operating convenience, are available for Genisco G-Accelerators, Models B78 and C159.

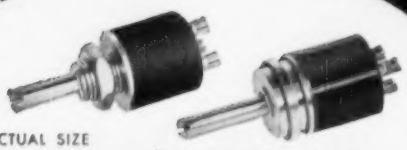
Modifications in any basic machine or accessories to meet your particular requirements will be carefully considered.

Genisco INCORPORATED

RELIABILITY FIRST

Want more information? Use post card on last page.

NEW! ½-inch wire-wound



ACTUAL SIZE

UP TO 250 K

PRECISION POTENTIOMETERS

NOW YOU CAN specify a Waters pot for miniaturized designs that require potentiometers up to 250K. In the reliability-proved construction of the AP-½, these new, higher values give you:

- ***Resistances — 10 ohms to 250 kilohms***
- ***Ganging — up to four units***
- ***Three mounting styles — plain-bushing, split-bushing, or servo***
- ***Three terminal styles — radial, axial, or wire-lead***
- ***Automation models — for printed circuits***

General specifications: Centerless-ground, stainless-steel shaft can be sealed with O-ring; gold-plated, fork-type terminals standard; 2% standard linearity for 50K and above — 5% for lower values; temperature range −55 to +105C, to 125C on order; 2 watts at 80C; anodized aluminum body ½" diameter × ½" long — ⅝" long for 100K and 250K; corrosion-resistant-alloy bushing; all electrical connections spot-welded or soldered; furnished with stops or for continuous rotation. *Write for data sheet on these dependable ½" potentiometers.*

COMING SOON!

Complete new family of
Waters precision potentiometers

WATERS MANUFACTURING, inc.
Wayland, Massachusetts
Mail address: P.O. Box 366, So. Sudbury, Mass.
APPLICATION ENGINEERING OFFICES IN PRINCIPAL CITIES

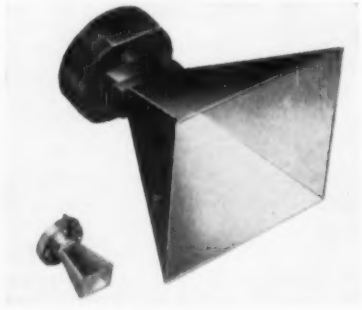
MFG. INC.

and is ideally suited for Schering and other bridges. The sensitivity is 3 μv for 1-percent deflection. Built-in tuned circuits permit a sharp balance even when the null is complicated by harmonics. **Circle P40 inside back cover.**

GEARHEADS
for standard servomotors

FEEDBACK CONTROLS, INC., 899 Main St., Waltham, Mass., have designed models G-11, G-15 and G-18 precision gearheads to withstand the severe mechanical and thermal environments encountered in military and industrial applications. A special flush-collar mounting insures permanently accurate mesh of motor pinion and first gear.

Exacting quality control of parts, ABEC-5 ball bearings and careful selection of materials combine to make these gearheads top-performance, long-lived components. They are available from stock in ratios from 10-to-1 to more than 4,000-to-1. **Circle P41 inside back cover.**



ANTENNA HORNS
1,000 to 40,000 mc

J. V. M. ENGINEERING CO., 4633 Lawndale Ave., Lyons, Ill., has available a complete line of cus-

Can your business co-exist with 70 million captive people?

As long as an Iron Curtain shuts off the satellite countries of Europe, the framework and future of free enterprise will be in danger.

There is proof before us every day that the world can prosper fully only when men *everywhere* are free to choose their own way of life, build their own businesses and till their own land. Yet behind the Iron Curtain 70 million people are still virtual prisoners of the Communists.

There are a number of ways you and other American businessmen can help these people, yourselves and the world. One of the most direct is through Crusade for Freedom, sponsor of Radio Free Europe.

For six years, this powerful overseas broadcasting operation has been beaming the truth into five key satellite countries. It has been outstandingly successful.

The Communists have spent fabulous sums trying unsuccessfully to jam RFE's programs. The bill for this last year in Poland alone was estimated at $17,000,000. *Two-thirds of this amount will support the entire RFE operation for another critical year!*

And we know from letters and reports that truth from Radio Free Europe has helped keep alive the desire for freedom. The proof is history.

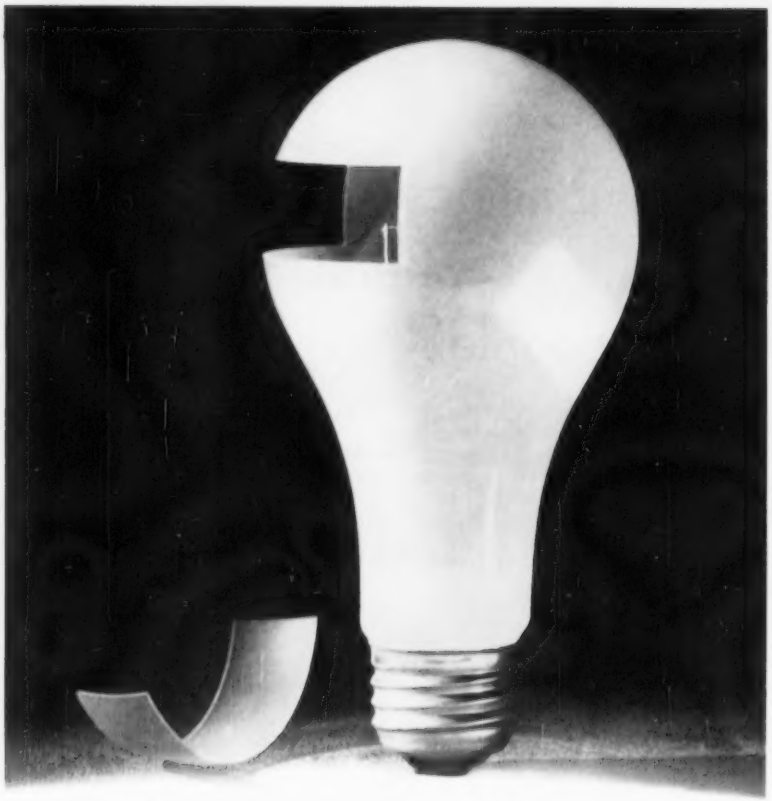
So give your generous support to Crusade for Freedom in aiding these 70 million captives. If *you* don't send them the truth – who will?

Some ways business executives have helped. Check the ones you are interested in.

- ☐ Display Crusade material on your company bulletin board.
- ☐ Plan a paycheck stuffer to inform your employees of the importance of the Crusade for Freedom.
- ☐ Plan to conduct an in-company solicitation.
- ☐ Match employee funds with your *Truth Dollars*.

PUBLIC SERVICE ADVERTISING COUNCIL

For campaign material and information write **CRUSADE FOR FREEDOM,** 345 East 46th St., N. Y. C. 17.



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Industrial Airbrasive® Unit

This delicate cutting job was done with our Industrial Airbrasive Unit . . . just to show you how its high-speed, gas-propelled stream of abrasive particles produces a fast . . . cool . . . shockless cutting action

New industrial uses for the S. S. WHITE Industrial Airbrasive Unit are being discovered every day. Developed from the Airdent® equipment made by S. S. WHITE for the dental profession, the unit can be used in wire-stripping . . . calibrating . . . to remove surface deposits . . . etch glass . . . cut germanium and other crystalline forms . . . or to etch, drill or light-debur almost every hard, brittle material.

The Airbrasive Unit does these, and many other jobs that used to be difficult — or downright impossible — to accomplish by previously known methods. Think of your own product. Do you have a process that our unit can solve? Send us a sample and let us try out the unit for you. Or, for further information, just write to

S. S. White
First Name in Airbrasive Cutting

S. S. White Industrial Division, Dept. EU
10 East 40th St., New York 16, N. Y.
Western Office: 1839 West Pico Blvd., Los Angeles 6, Calif.

tom-built antenna horns, ranging from 1,000 to 40,000 mc, in standard or special designs. Beam width and antenna gain can be provided to individual specifications. Comparative dimensions are illustrated. The small horn, measuring 0.280 in. by 0.140 in., is for short range communication, laboratory use or as a field testing device for radar or similar equipment.

All horns can be supplied with quick disconnect for ease of installation and interchangeability. Silver and rhodium are used for all internal electrical working surfaces to provide maximum resistance to corrosion. Silver brazed assembly provides high mechanical strength. **Circle P42 inside back cover.**

A-C MILLIVOLTMETER
a portable unit

FISHER RESEARCH LABORATORY, INC., 1961 University Ave., Palo Alto, Calif. A new portable, battery-operated transistorized millivoltmeter makes a-c measurements to 50 μv accurately. It is useful for in-the-field measurements for telephone and carrier equipment, for marine, aircraft and other mobile equipment, for general laboratory use and as a broadband amplifier. Floating voltages are easily measured. Difficulties due to line voltage fluctuations and 60-cps beating are completely eliminated.

Twelve full-scale ranges between 0.001 and 300 v a-c are provided as well as decibel coverage between −80 and +52 dbm. Usable frequency coverage is provided between 1 cycle and 5 mc. Accuracy is ±3 percent between 5 cps and 1 mc. Input impedance is 22 megohms.

Battery power provides 400

world-wide approval

Pye Telecommunications Limited are now marketing the widest and most modern range of V.H.F. fixed and mobile radio-telephone equipment available in the world. This range of equipment has been designed to expand the application of Pye Radio-Telephones already in constant use in 77 different countries.

Pye Ranger V.H.F. equipment has now received approval from the British G.P.O. for Land, Marine and International Marine applications employing A.M. or F.M. systems, type approval from the Canadian D.O.T., and type acceptance of the F.C.C. of the United States of America.

No other Company holds so many approvals for this range of equipment, which now covers every conceivable requirement.

We can offer

FREQUENCY RANGE
All frequencies from 25 to 174 Mc/s

POWER RANGE
All powers up to 1 Kilowatt.

CHANNEL SPACING
All channel spacings including 20 and 25 kc/s in full production.

MODULATION
A.M. or F.M.

No matter what your V.H.F. requirements are, Pye Telecommunications Ltd., can fulfil them. Your enquiries are invited.

Leading the world in V.H.F. RADIO-COMMUNICATION

Pye Canada Ltd., 82 Northline Road, Toronto, Canada

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PYE TELECOMMUNICATIONS LTD · CAMBRIDGE · ENGLAND

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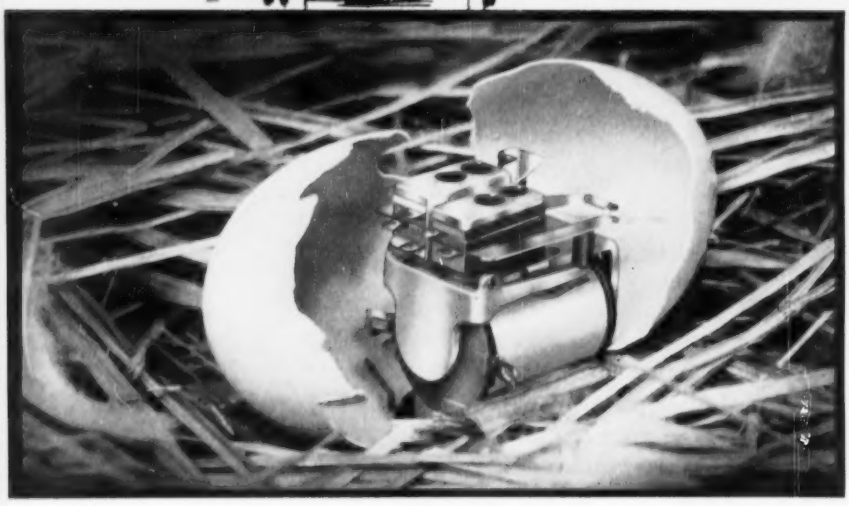
"It's something he hatched out with the man from PHILLIPS"



COIL CHARACTERISTICS
Operating voltage: up to 200 volts D.C.
Resistance: up to 16000 ohms
Single or double wound
Operating time: 0.050 sec., max.
0.003 sec., min.

CONTACT ASSEMBLY
All forms A, B, or C
Single or double pile-up
Code #4 Palladium contacts, standard
Other contacts available

MOUNTING
Two No. 4-40 tapped holes, standard
Other mountings available

VARIATIONS
Plug-in mounting and terminals
Printed circuit terminals
Taper tab terminals
Metal enclosures
Hermetically sealed

***your* problem hard-boiled?** Type 4C was developed for coddling those requirements of maximum sensitivity and long life in a minimum space. It possesses a highly efficient magnetic circuit operating on a minimum of power. The armature backstop on Type 4C is stainless steel for maximum strength while the armature is fixed to a precision-ground stainless steel pin. A standard Phillips Type 4 contact spring assembly is used, however, all variations in contact arrangements and contact materials are available. Type 4 coils are available single or double wound, with time delay slugs and special windings for high-temperature and/or high humidity.

Let the "man from PHILLIPS" resolve your relay circuit problems.

HERMETIC SEALS, MULTI-CONTACT, POWER, HERMETICALLY SEALED RELAYS, ACTUATORS

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PHILLIPS CONTROL CORPORATION . . . JOLIET, ILLINOIS

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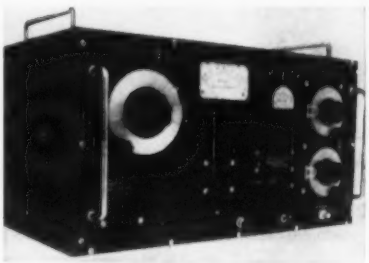
hours of continuous operation. The instrument measures 5 in. by 8 in. by 4 in. Weight is 5 lb. Price is $225. **Circle P43 inside back cover.**

CONNECTOR
rack and panel type

SCINTILLA DIVISION, Bendix Aviation Corp., Sidney, N. Y. Type SR rack and panel connector incorporates a solid shell and resilient insert to facilitate pressurization and to give maximum protection against the harmful effects of vibration. Other features include closed entry sockets, cadmium-plated irridite finish and operation in the temperature range of −67 to +250 F. Insert patterns will be available to mate with existing equipment now in service. **Circle P44 inside back cover.**

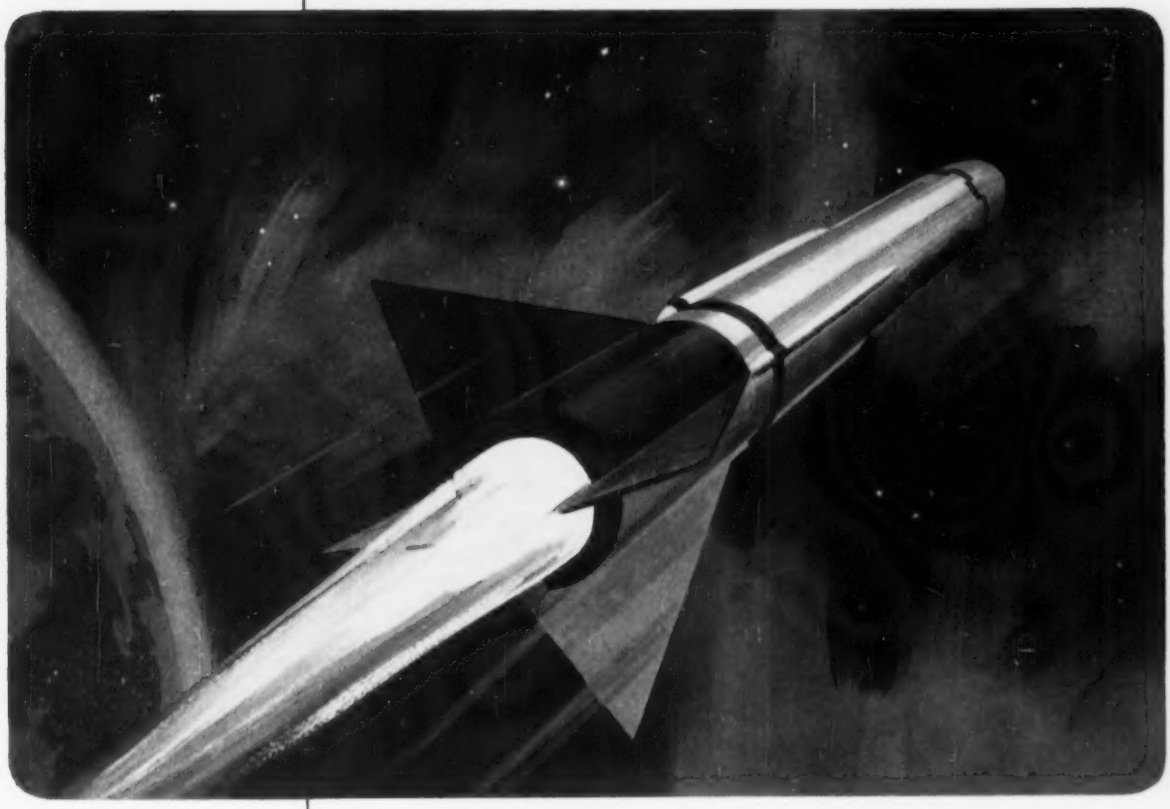


ANTENNA TESTER
quick and accurate

AMERICAN-EASTERN ELECTRONICS CO., LTD., Box 66, Rishon-Le-Zion, Israel, has developed an antenna impedance and harmonic power measuring instrument designed for making quick, accurate measurements and tests of antennas and feeder systems in the lower r-f spectrum.

Model 90 consists of a variable r-f generator capable of delivering

IMPORTANT DEVELOPMENTS AT JPL



The Jet Propulsion Laboratory is a stable research and development center located north of Pasadena in the foothills of the San Gabriel mountains. Covering an 80 acre area and employing 1700 people, it is close to attractive residential areas.

The Laboratory is staffed by the California Institute of Technology and develops its many projects in basic research under contract with the U.S. Government.

Opportunities open to qualified engineers of U.S. citizenship. Inquiries now invited.

Weapons Systems Responsibility

In the development of guided missile systems, the Jet Propulsion Laboratory maintains a complete and broad responsibility. From the earliest conception to production engineering—from research and development in electronics, guidance, aerodynamics, structures and propulsion, through field testing problems and actual troop use, full technical responsibility rests with JPL engineers and scientists.

The Laboratory is not only responsible for the missile system itself, including guidance, propulsion and airframe, but for all ground handling equipment necessary to insure a complete tactical weapons system.

One outstanding product of this type of systems responsibility is the "Corporal," a highly accurate surface-to-surface ballistic missile. This weapon, developed by JPL, and now in production elsewhere, can be found "on active service" wherever needed in the American defense pattern.

A prime attraction for scientists and engineers at JPL is the exceptional opportunity provided for original research afforded by close integration with vital and forward-looking programs. The Laboratory now has important positions open for qualified applicants for such interesting and challenging activities.

JOB OPPORTUNITIES IN THESE FIELDS NOW

jpl

ELECTRONICS • PHYSICS • SYSTEMS ANALYSIS
COMPUTER DEVELOPMENT • INSTRUMENTATION
TELEMETERING AND MECHANICAL ENGINEERING

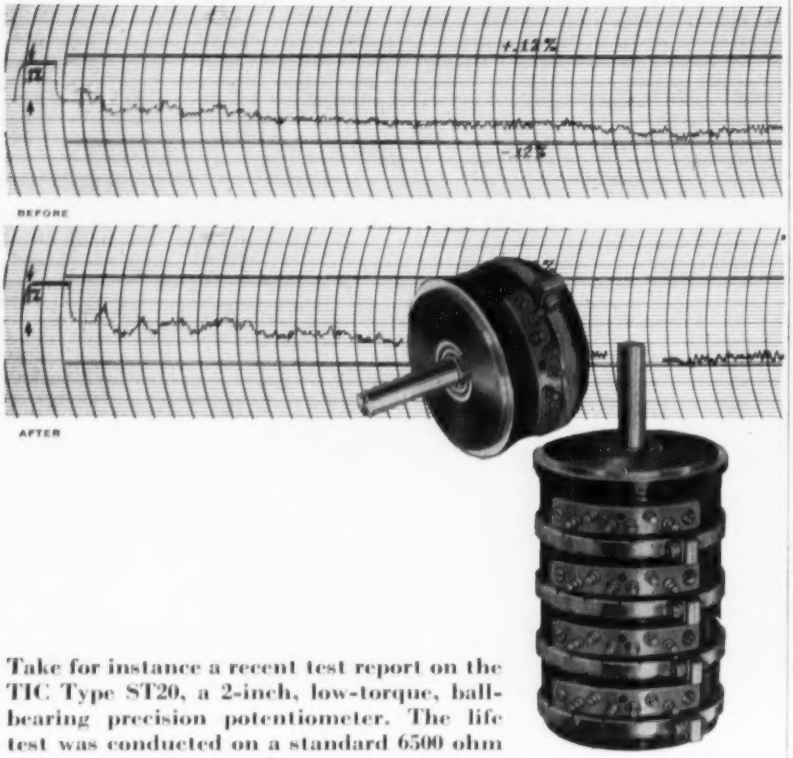
JET PROPULSION LABORATORY

A DIVISION OF CALIFORNIA INSTITUTE OF TECHNOLOGY

PASADENA • CALIFORNIA

LIFE IS NO PROBLEM

WITH TIC PRECISION POTENTIOMETERS



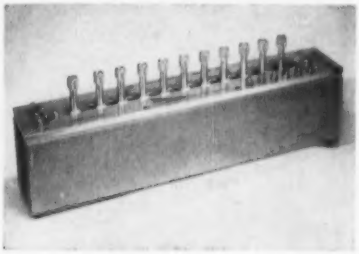
Take for instance a recent test report on the TIC Type ST20, a 2-inch, low-torque, ball-bearing precision potentiometer. The life test was conducted on a standard 6500 ohm unit. At 30RPM the ST20 was subjected to 700,000 cycles, reversing direction every 30 minutes. The linearity graphs shown above show the before and after of the ST20's independent linearity. *As can be seen, the linearity change is imperceptible.*

Some of the change in linearity after the life cycling can be attributed to change in effective resolution due to contact wear. Other results from the life test indicate less than 100 ohm equivalent noise resistance except for one spot, where it was less than 1000 ohms. The 1000 ohm spot was of such short duration that the linearity recording did not pick it up. Test Summary: The ST20 will perform with only infinitesimal degradation for over 700,000 cycles. If it's long life *at full precision performance*, that you want, specify precision potentiometers by TIC.

TECHNOLOGY INSTRUMENT CORP.

569 Main Street, Acton, Mass. COlonial 3-7711
West Coast Mail Address, Box 3941, No. Hollywood, Calif. POplar 5-8620

up to 3 w of power, a matching section composed of adjustable inductors, an output current meter and an accurate R-C bridge with a sensitive null indicator. Among its features are a logarithmic current meter and a logarithmic amplifier (almost 100 db on a single scale) for the null indicator. The instrument is completely self-contained, designed for simplicity in operation and intended for use in laboratories and receiving stations. **Circle P45 inside back cover.**



DELAY LINE
with 10 pickup coils

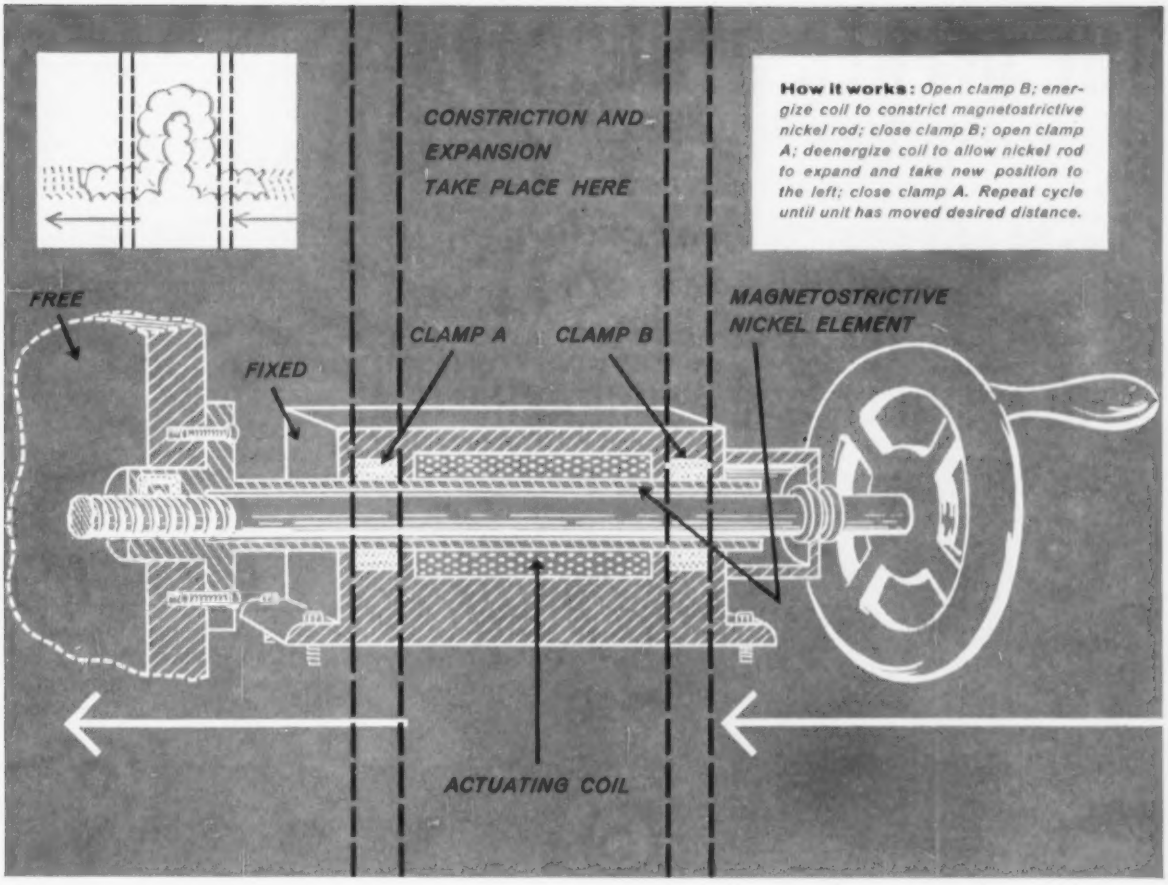
DELTIME, INC., 608 Fayette Ave., Mamaroneck, N. Y., has announced a modified model 103 delay line with 10 pickup coils instead of the previous four. Range is from 2 to 40 μsec with 10 continuously adjustable outputs. Each pickup coil slides along the calibrated slot and is locked in place by its knurled thumbscrew. As many as 20 pickup coils can be accommodated in the standard design and case without noticeable reduction of output due to loading.

The closest juxtaposition is about 2 μsec. Input impedance is 50 ohms; output, 500 ohms.

The delay line is based on the magnetostrictive principle utilizing a nickel element. Only 12 in. by 2 in. by 3 in., the delay lines are available as individual lab instruments or as built-in equipment for an assembly. **Circle P46 inside back cover.**

PAPER CAPACITOR
upright mounting type

AEROVOX CORP., New Bedford, Mass., has available a new, economical, upright mounting ca-


CONSTRICTION AND EXPANSION TAKE PLACE HERE
How it works: Open clamp B; energize coil to constrict magnetostrictive nickel rod; close clamp B; open clamp A; deenergize coil to allow nickel rod to expand and take new position to the left; close clamp A. Repeat cycle until unit has moved desired distance.
FREE
FIXED
CLAMP A
CLAMP B
MAGNETOSTRICTIVE NICKEL ELEMENT
ACTUATING COIL

Novel Inchworm Motor positions work to 0.000,005-inch accuracy

New heavy-duty micro-feed relies on Magnetostrictive nickel

Place nickel in a magnetic field and it shrinks.

Remove it, and it snaps back to size.

Magnetostriction is the reason. And nickel exhibits large magnetostrictive length change . . . added to its rugged mechanical properties and moderate cost. Result: a reliable, versatile engineering material.

Take, for example, the novel "Inchworm" motor manufactured by Airborne Instruments Laboratory, Inc., Mineola, N. Y. An extremely accurate feed mechanism for centerless grinders, this device uses a coordinated pair of clamps to convert the magnetostrictive expansion and contraction of a nickel rod into linear incremental motion. Powerful motion, too . . . the "Inchworm" will move a 350-pound load in steps variable up to 0.000,060-inch.

You can see the mechanics of The Inchworm in the illustration above. Electronic controls include standard timing and power circuits to energize the coil and operate the clamps for forward and backward steps. An optional gauge and feedback circuit allow full automatic control.

Magnetostrictive transducers made of nickel have many industrial uses today . . . as sonar, vibratory drills, ultrasonic cleaners, homogenizers, soldering devices.

Maybe you would like to explore this growing design field. For recommended materials, get in touch with us. Write for our booklets, *Magnetostriction*, or *Design of Nickel Magnetostrictive Transducers*. They're yours for the asking.

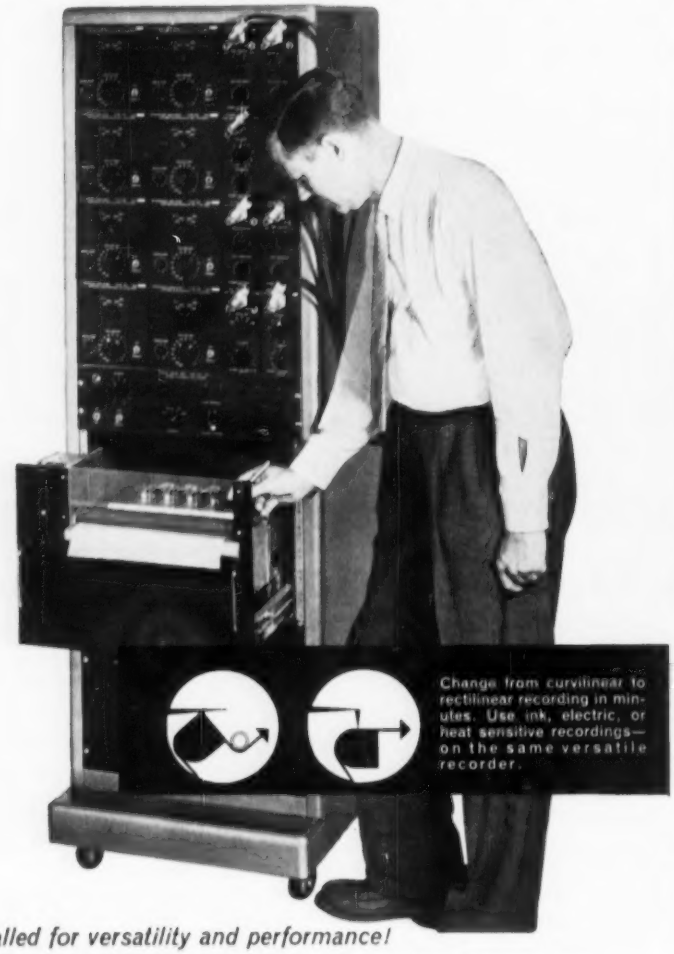
The INTERNATIONAL NICKEL COMPANY, Inc.
67 Wall Street New York 5, N. Y.

INCO TRADE MARK **NICKEL**... *for magnetostriction*

THE OFFNER DYNOGRAPH

...rectilinear recording
...curvilinear recording
...heat sensitive recording
...electric recording
...ink recording

IN A SINGLE OSCILLOGRAPH!

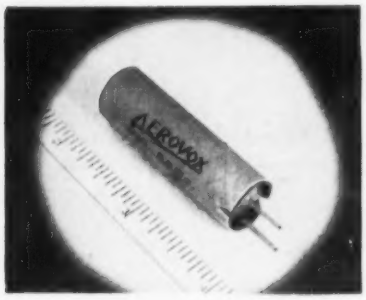

Change from curvilinear to rectilinear recording in minutes. Use ink, electric, or heat sensitive recordings—on the same versatile recorder.

unequalled for versatility and performance!

High sensitivity—up to 15 microvolts d-c per mm. Stable—absolute zero base-line drift. No "warm-up"—immediately stable and ready for use. One percent linearity—over 8 centimeters deflection. One amplifier—for all recording applications.

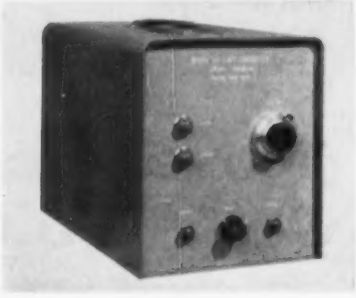
Write for 12 page, 2 color catalog—gives specifications and details.

OFFNER ELECTRONICS INC.
5324 N. KEDZIE AVE. • CHICAGO 25, ILL.



pacitor designed especially for use in printed-wiring assemblies. Type P-156 consists of the standard paper tubular capacitor adapted for upright mounting by an outer insulating sleeve.

Provision is made at the base of the capacitor to permit free circulation of air. The outer lead always indicates outside foil. Standard packaging includes a new styrofoam pad to keep all leads clean and straight and to facilitate handling on assembly lines. Complete details are available. **Circle P47 inside back cover.**



LIMIT CONTROLLER
for transformer transducers

DAYTRONIC CORP., 216 S. Main St., Dayton 2, Ohio. Highly accurate automatic inspection, monitoring and/or control of size, weight stress, pressure, flow, acceleration or any other quantity measurable by differential-transformer transducers is accomplished using the new model 561 limit controller.

Any desired control point in the range of a standard transducer can be preset on a 10-turn dial. Thereafter, an output relay closes whenever the input quantity equals or exceeds the preset limit and opens when it falls below the limit. Operating time is approximately 0.05 sec. Relay contacts operate panel lamps and external

"now I can service our Sphygmomanometer* thanks to Formica® XXXP-36"

This sphygmomanometer – or *automatic blood pressure recorder, if you prefer – demonstrates how manufacturers of electronic products cut field service cost with Formica copper clad laminates.

Through its cold fabricating grades, Formica contributes the dimensional stability and accuracy essential for absolute interchangeability of components.

For example, with the circuit uniformity that Formica XXXP-36 provides, Colson Corporation, Elyria, Ohio, now services its automatic blood pressure recorder by phone and mail. Formerly skilled technicians had to be sent out from the factory.

And that's not all. Formica XXXP-36 also offers 1,000,000 megohms insulation resistance, low moisture absorption, translucency, watermarking . . . and uniform color from lot to lot.

Why not design your products to get the full benefit of printed circuitry? You can with Formica copper clad. And remember, Formica gives you the widest choice of base laminates, including over 12 grades made of paper and nylon, glass and cotton cloth . . . impregnated with epoxy, phenolic and melamine resins. For complete information, send today for Copper Clad Technical Data, form 688. Formica Corporation, a subsidiary of American Cyanamid, 4530-7 Spring Grove Ave., Cincinnati 32, Ohio.

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Formica-4, the complete laminated plastics service, cuts your engineering time—reduces component parts cost—and assures delivery for mass production schedules.

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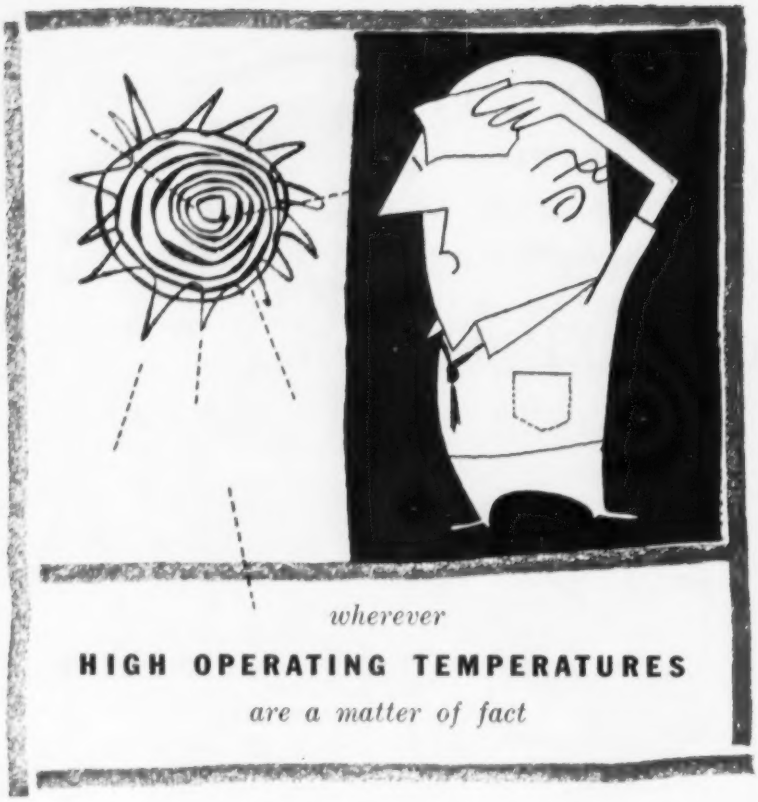

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Then it's time to face the facts. Just any insulated wire or cable won't meet the test. But you can be sure that there's a Continental heat-resistant wire or cable that will. And when you meet high operating temperatures combined with moisture and corrosive vapor problems, the fact of the matter is ONE Continental wire that offers insulated advantages to meet your requirements all ways.

ELECTRONIC INSTRUMENT INSULATED WIRE

600-3000 volt service. Sizes: 32 AWG to 6 AWG inclusive.
CONSTRUCTION: stranded tinned copper, polyvinyl insulation with or without nylon jacket. Maximum operating temperature: 100°C.
CONFORMS TO: MIL-W-16878B
COLOR CODED: 1, 2, or 3 spiral stripes over polyvinyl insulation.

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Continental

WIRE CORPORATION

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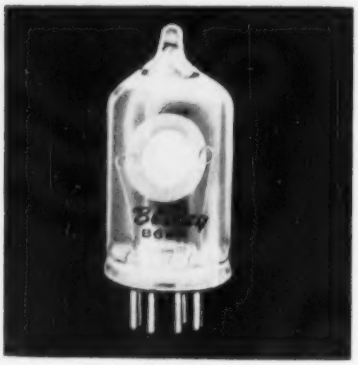
alarm or control devices.

A unique null-balance principle gives stable repeatability of 0.000025 in. or 0.1 percent of transducer span. Linearity is 0.1 percent. Weight is 13 lb. It is available portable or rack mounted. Price is $345. **Circle P48 inside back cover.**



QUARTZ CRYSTAL
for high reliability uses

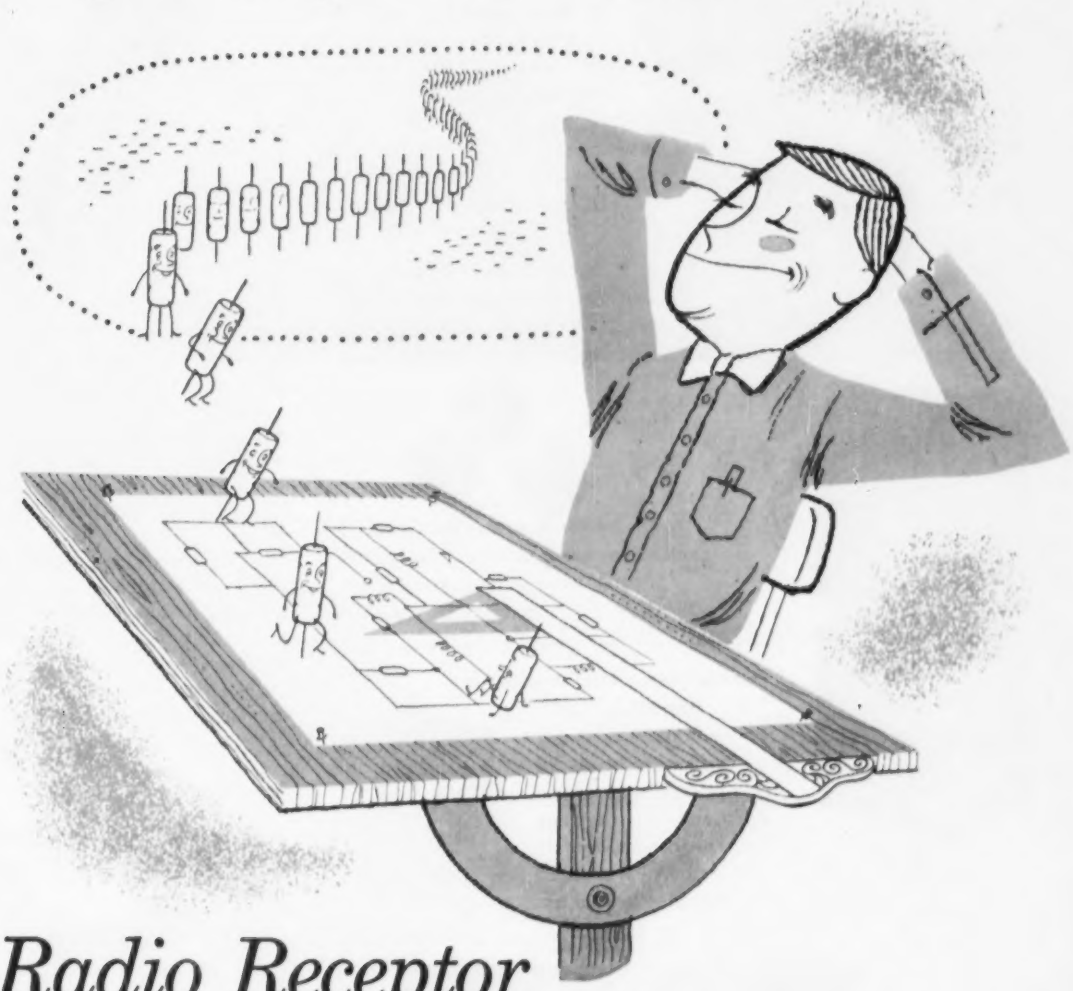
BLILEY ELECTRIC CO., Union Station Bldg., Erie, Pa. Type BG6A vacuum-mounted quartz crystal unit features an AT-cut element produced with newly developed process techniques which reduce aging to a minimum, insuring high reliability. Tolerance of the unit is ±0.0005 percent of nominal frequency at 25 C; stability is ±0.0015-percent maximum deviation from measured frequency at 25 C over the ambient range from −55 C to +90 C; aging is 2.0 ppm maximum during the first year of service under low drive conditions. The overall dimension is 2½ in., vacuum mounted in a T-5½ bulb, small button miniature base.

Complete design specifications are given in bulletin 496. **Circle P49 inside back cover.**

DEMODULATOR
for airborne applications

ATLAS ELECTRO-MECHANICAL LABORATORIES, INC., 14734 Arminta St., Panorama City, Calif. Model ED551 electronic demodulator compares an a-c signal input to a fixed reference. Variations in phase and amplitude between the input and reference furnish a

Making drawing board dreams come true!



Radio Receptor

Germanium Diodes

You electronic engineers show limitless imagination and ingenuity, but to help translate ideas into reality you need extra special components, such as Radio Receptor Gold Bonded Diodes. Right now they are being used successfully by many top-flight companies whose circuits require high forward conductance coupled with other stringent characteristics – and the ability to take a beating under grueling conditions.

A complete range of RRco. diode types is available – and if you haven't found the type *your* circuit calls for, no doubt we can make it specially for you. So, if diodes can possibly help your project, consult our engineers without obligation. Write Dept. E-5

Semiconductor Division

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Radio Receptor Products for Industry and Government: Selenium Rectifiers • Germanium Diodes
Thermatron Dielectric Heating Generators & Presses • Communications, Radar & Navigation Equipment

Want more information? Use post card on last page.

WHAT'S BEHIND THE SIGMA SERIES 72 TELEGRAPH RELAY ?

The "72", as a polarized relay particularly suited to telegraph use, offers a combination of extremely worthwhile operating features. Among them are 500 pulse-per-second speed, freedom from maintenance for at least a half a billion operations (60 ma. 120 VDC inductive load), adjustable bias and sensitivity.

In addition, the usefulness of 72's in telegraph service is also substantially increased by the following three related items:

STANDARD REPAIR KIT for the 72 contains normally (and easily) replaceable parts: two contact screws and one ferro-nickel armature.

MAINTENANCE AND ADJUSTMENT MANUAL for the 72 describes in detail all service operations likely to be needed in the field. What and what not to do, and the appropriate methods, are comprehensively set forth and illustrated in 18 pages. Available to 72 users.

MODEL 4501 TEST SET permits thorough operational checking and adjustment, using either or both coils, of the relay under test.* Measures operating ("trip") values (either manually or automatically), bias, percent-break, and insulation. Provision is also made for connecting an external drive directly on relay coils, and 'scope connection for observing contact performance in bias and percent-break tests. Standard relay rack panel mounting, 5¼" high, less than 6" deep. Case, socket adapters and instruction manual included.

*The Test Set is simply a useful —but not vital— accessory to telegraph relay use. It performs the described tests on not only the Sigma Series 72 relay, but on our Series 7, the WE 255A (which our 72AOZ-160 TS can replace), the WE 215, and similar relays.

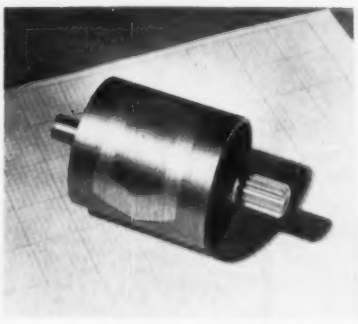
SIGMA

SIGMA INSTRUMENTS, INC.
62 Pearl St., South Braintree 85, Mass.

d-c voltage output which is a direct measurement of the phase and amplitude difference between the input and the fixed reference.

Input voltage is 0 to 15 v rms; reference voltage, 0 to 25 v rms; output voltage, 0 to 10 v d-c; frequency response, 30 cps to 100 kc; size, 1¼ in. diameter by 3¼ in. long.

The demodulator may be supplied with either a plug-in or solder-type header. Its ruggedness together with its stability versus extreme temperature variations characteristics, permit its use for missile and other airborne applications. **Circle P50 inside back cover.**



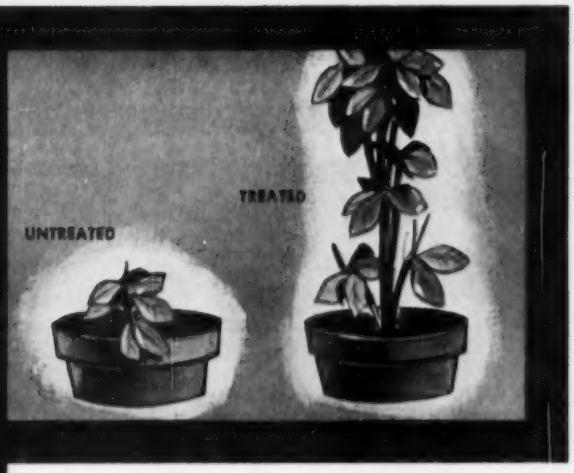
BRUSHLESS ALTERNATOR
faster, smaller, lighter

BEKEY ELECTRIC CO., INC., 1327 S. Main St., Los Angeles 15, Calif. A new synchronous alternator was developed for high speed application. This machine operates without rotating windings. The illustration shows the smooth metallic cylinder which replaces the salient poles. Tests were performed at speeds up to 60,000 rpm with excellent results. The machine can operate as a synchronous motor, alternator or

For additional information on all items on this page, use post card on last page.

tomorrow is here today!

Botanists who have long wondered if a plant growth accelerator was possible are now flabbergasted by an amazing new chemical development—Gibberellic Acid. A dose as small as .000001 gram can induce a plant to phenomenal growth and flowering . . . four to five times its normal height, maturing ahead of schedule. What effect would Gibberellic Acid have on humans? . . . scientists will soon have the answer!



new series 402 PRECISION

direct reading frequency meters

C402A

F-R SERIES 402 new line of temperature compensated Precision Direct Reading Frequency Meters provides simplified operation with improved accuracy. The SERIES 402 is designed for maximum scale legibility to increase the efficiency of frequency measurements.

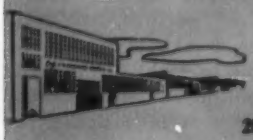
features:

- Direct reading over full waveguide frequency range
- High resolution and accuracy
- Hermetically sealed Invar cavity
- Rugged mechanical construction
- Reaction type coupling; 35% nominal dip
- Non-contacting tuning plunger
- High Q: approximately 8,000

SERIES 402 PRECISION DIRECT READING FREQUENCY METERS

TYPE NO.	FREQUENCY RANGE (KMc/s)	WAVEGUIDE SIZE	FLANGE TYPE	ABSOLUTE ACCURACY*		SMALLEST SCALE DIVISION
				ROOM TEMP.	—40° to +55°C	
C402A	5.85 to 8.20	1½ x ¾	UG-344/u	0.01%	.03%	1.0 Mc
X402A	8.20 to 12.40	1 x ½	UG-39/u	0.015%	.03%	2.0 Mc

*Dial connection chart intregal with unit.



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F-R MACHINE WORKS, Inc.

28-12 Borough Place, Woodside 77, N. Y. AStoria 8-2900

Write TODAY for new catalog of complete line of Precision Microwave Test Equipment

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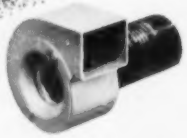
HEART of your miniaturization program

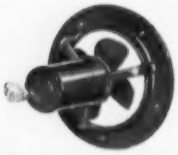
the EAD 1" MOTOR

Here is EAD's outstanding contribution to the miniaturization program . . . a one-inch diameter, 400 cycle precision motor, engineered for long life and high efficiency. Where minimum size and weight are essential, use this versatile unit. Modifications include high ambient and high altitude versions as well as low voltage designs.

MINIATURE TUBE AXIAL BLOWERS
For efficient cooling and air change in small electronic equipment. Driven by EAD's 1" dia. motor. No brushes, no arcing, no interference.



SUBMINIATURE CENTRIFUGAL BLOWERS
For spot cooling. Moves 9 CFM at 1.35 S.P. Powered by EAD's 1" dia. motor.



MINIATURE RING MOUNTED FANS
For peak performance, compactness, dependability. Blade dia. small as 2" — air del. greater than many heavier blowers. Uses EAD's 1" dia. motor.

MINIATURE GEAR MOTORS
Servo, synchronous or induction units, primarily for 400 cycle and var. freq. operation. Gear ratios up to 10,000 to 1. Basic types use EAD's 1" dia. motor.

MINIATURE SINE WAVE ALTERNATORS
For very pure sine wave voltage, high power output. Low distortion, light weight, permanent magnet fields. Frame sizes begin with 1" diameters.

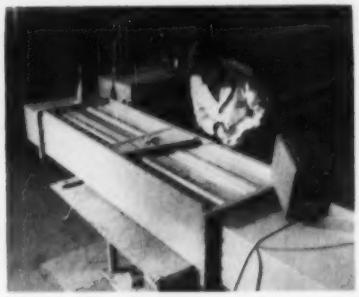
Complete specifications available on request.

EASTERN AIR DEVICES, INC.

SOLVING SPECIAL PROBLEMS IS ROUTINE AT EAD

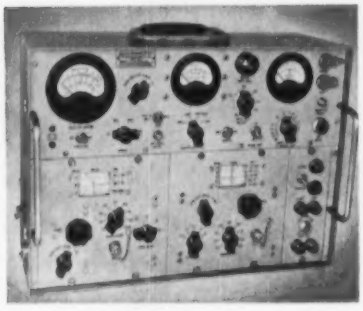
387 Central Ave., Dover, New Hampshire

doubly fed motor. A bulletin describing operation and sizes is available. **Circle P51 inside back cover.**



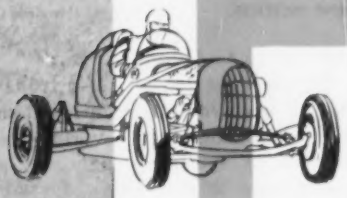
SLOTTED LINE
for waveguides

I-T-E CIRCUIT BREAKER CO., 601 E. Erie Ave., Philadelphia 34, Pa. Developed to fill a need in the field of lower frequency radars and scatter communications systems, this slotted line for waveguide, size WR-2100, features bolted and dowled aluminum construction with probes tunable over the entire frequency band. It has an inherent vswr of less than 1.02 over the entire applicable band. Slope is less than 1.005 vswr. Sizes currently being supplied to military and commercial installations range from WR-770 through WR-2300. **Circle P52 inside back cover.**



T-R TEST SET
for 190 kc-400 mc range

TRAD ELECTRONIC CORP., Asbury Park, N. J. The RT-500 transmitter-receiver performance test set analyzes weakness and predicts possible in-flight failures of electronic equipment on aircraft. The portable unit is designed to furnish all necessary performance measurements on t-r equipment in



Would you haul
a 10-ton load
in a racing car . . .
. . . or in a truck?

the reason for your answer
is your reason for choosing the

Amperex 6800

20 KW INDUSTRIAL TRIODE

The AMPEREX 6800 has been designed from the ground up for brute force and ruggedness. That's what you need for industrial loads. It does not require the characteristics of a communications tube designed for performance at high frequencies. As a result, it costs considerably less to produce. The difference in engineering and manufacturing costs has been passed on to you. The 6800 costs incomparably less than communications-type tubes of similar power capabilities—yet it will deliver over 20 kilowatts with outstanding performance into industrial loads in induction heating and similar applications.

So—don't buy a racing car when you need a heavy-duty truck. Send for spec sheets on the Amperex 6800.

Net user price: **$350.00**

MAXIMUM RATINGS AND TYPICAL OPERATING CONDITIONS
RF Power Amplifier and Oscillator — Class C Maximum
CSS RATINGS, ABSOLUTE VALUES

D-C Plate Voltage	15,000 volts	D-C Grid Current	0.50 amps
D-C Grid Voltage	—1,800 volts	Plate Input	45 kw
D-C Plate Current	3.5 amps	Plate Dissipation	20 kw

TYPICAL OPERATION

D-C Plate Voltage	12,500 volts	D-C Grid Current (approx.)	0.25 amps
D-C Grid Voltage	—1,200 volts	Driving Power (approx.)	500 watts
Peak R-F Grid Voltage	2,000 volts	Plate Power Output	33 kw
D-C Plate Current	3.5 amps	Industrial Load Output (approx.)	22 kw*

**In induction heating applications, the tube will deliver in excess of 20 kw measured as BTU equivalent in the load.*

CHECK THESE INDUSTRIAL FEATURES

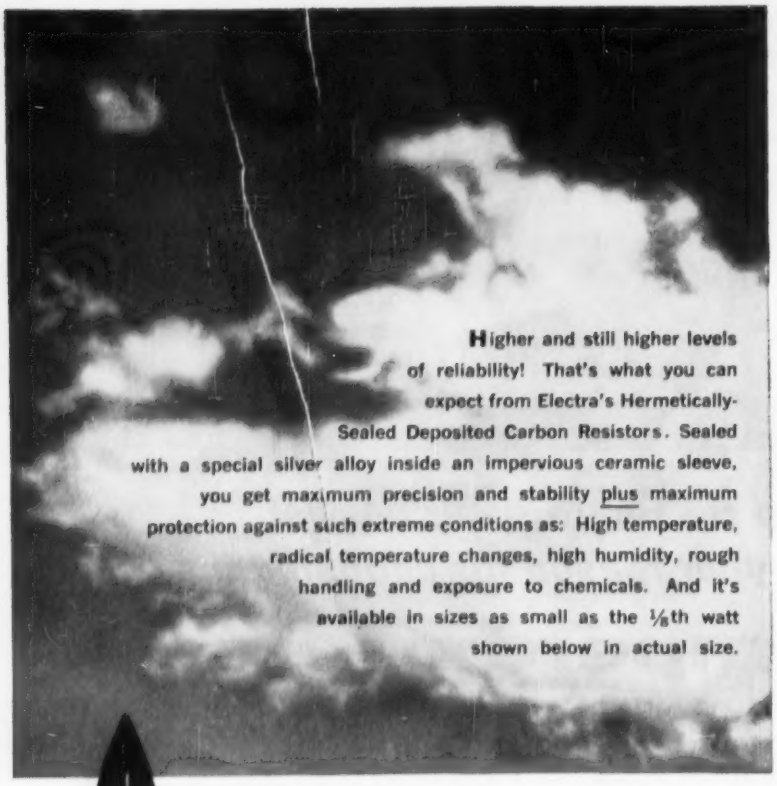
- Rugged economical tube for induction and dielectric heating up to 30 megacycles.
- Heavy wall, high-heat-capacity anode is capable of absorbing intermittent overloads.
- Thoriated tungsten filament for longer life and low filament power.
- Proven reliability in actual industrial use in the field.

Amperex has a tube for *all* of your industrial requirements—including power oscillator tubes, rectifiers, ignitrons, thyratrons, and others. Write for the condensed Amperex tube catalog — a complete listing of all Amperex products.

Amperex ELECTRONIC CORP.
230 Duffy Avenue, Hicksville, Long Island, N. Y.

In Canada: Rogers Electronic Tubes & Components, 11-19 Brentcliffe Road, Leaside, Toronto 17.

AMPEREX


Higher and still higher levels of reliability! That's what you can expect from Electra's Hermetically-Sealed Deposited Carbon Resistors. Sealed with a special silver alloy inside an impervious ceramic sleeve, you get maximum precision and stability plus maximum protection against such extreme conditions as: High temperature, radical temperature changes, high humidity, rough handling and exposure to chemicals. And it's available in sizes as small as the 1/8th watt shown below in actual size.

Sealed-in Reliability

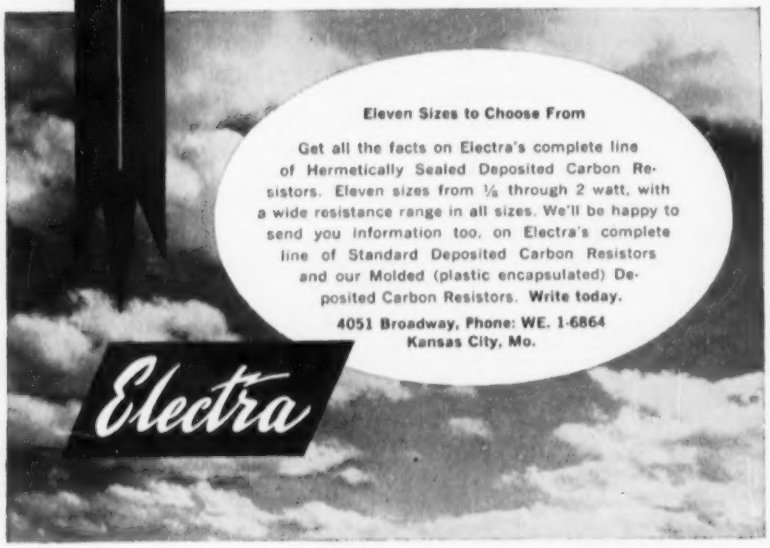
IN SMALL SIZES

ELECTRA

DEPOSITED CARBON

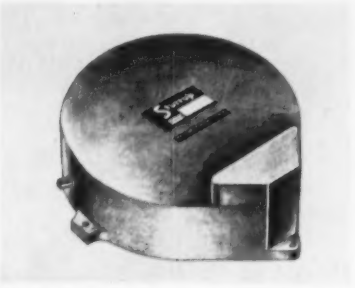
RESISTORS

HERMETICALLY SEALED


Eleven Sizes to Choose From
Get all the facts on Electra's complete line of Hermetically Sealed Deposited Carbon Resistors. Eleven sizes from 1/8 through 2 watt, with a wide resistance range in all sizes. We'll be happy to send you information too, on Electra's complete line of Standard Deposited Carbon Resistors and our Molded (plastic encapsulated) Deposited Carbon Resistors. Write today.
4051 Broadway, Phone: WE. 1-6864
Kansas City, Mo.
Electra

the 190 kc to 400-mc range.

The test set consists of a transmitter performance monitor, two r-f signal generators covering the 190 kc to 400 mc range and a multirange 20,000 ohm per volt d-c or 5,000 ohm per volt a-c meter. It has been approved by BuAer-Navy. **Circle P53 inside back cover.**

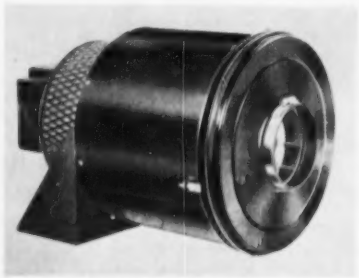


DELAY LINE
features new design

STURRUP, INC., 50 Silver St., Middletown, Conn. The Polyplane delay line introduces a new concept in the manufacture of solid ultrasonic delay lines and makes possible longer delays than heretofore available—6,000 μsec and longer.

The Polyplane design permits the use of smaller quartz blanks for virtually all delays resulting in a more compact and lighter weight unit. This design also results in a general reduction of spurious response and low bandpass ripple.

Complete details are available from the company. **Circle P54 inside back cover.**



MULTISTAGE BLOWER
for computer applications

ROTRON MFG. CO., Schoonmaker Lane, Woodstock, N. Y. A line of

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FIRST IN AVIATION

New High-Temperature UNION AC Relay rated from -65° C. to 125° C., 115 Volt, 60 to 400 cycles. Suitable for airborne circuits, including jet planes and missiles.

Miniature relay applications are getting hotter all the time—and many of them call for self-contained AC relays.

To meet these needs, UNION has developed AC relays incorporating silicon rectifier assemblies. They'll withstand temperatures from -65° C. to 125° C. The size is the same as the 85° C. UNION AC Relay.

New Hi-Lo Contacts, *too!* These contacts permit switching loads of two amperes or dry-circuitry level in the one relay. Or, you can get gold alloy contacts for dry-circuitry use.

OTHER ADVANTAGES

Vibration resistance up to 1,000 cycles at 15 G's and shock in excess of 50 G's.

Life expectancy. Tested through 1,000,000 operations.

Coil resistance. 3,700 ohms.

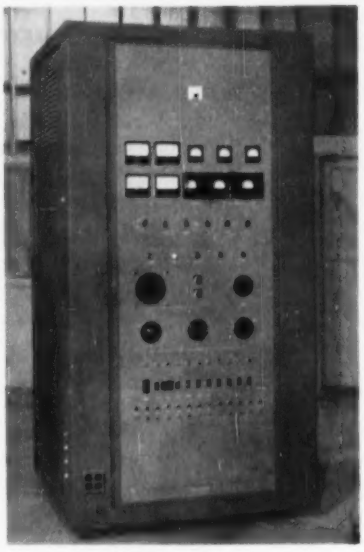
Small size, lightweight. Measures only ½" higher than our DC relays and weighs about 5 oz. All other construction features are the same as the DC relay.

Types and Mountings. Available in 6 PDT or 4 PDT models, plug-in or solder-lug connections and all the usual mountings.
Meets or exceeds all requirements of MIL-R-5757-C, MIL-R-25018, and MIL-R-6106B.
Write for complete information. Ask for *Bulletin 1012.*

GENERAL APPARATUS SALES
UNION SWITCH & SIGNAL
DIVISION OF WESTINGHOUSE AIR BRAKE COMPANY
PITTSBURGH 18, PENNSYLVANIA

new multistage centrifugal blowers allow delivery of 25 to 350 cfm at static pressure of 10 to 55 inches water column (2 psi) on suction or pressure. These blowers incorporate three to nine cascaded pressure stages. They have no wearing parts and are direct-coupled (no belts) to a ¼ to 2-hp induction motor which is an integral part of the unit. The shaft speed of the blower being only 3,400 rpm, noise levels are relatively very low.

The peculiar construction of the model L blowers results in small size and light weight as required by electronic, instrument and computer applications. This unit was primarily designed for computer tape slack control. Catalog sheets 40302-1 and 40302-2 give complete dimensional and performance specifications. **Circle P55 inside back cover.**



UFH TRANSMITTER
operates from 240-v source

LEVINTHAL ELECTRONIC PRODUCTS, INC., 760 Stanford Industrial Park, Palo Alto, Calif. The complete 375 to 750-mc model PC57 transmitter utilizes an Eimac X-564-B klystron to produce 15-kw peak power with maximum duty cycle of 0.1 Pulse length continuously variable from 4 to 3,000 μsec and repetition rate is continuously variable from 5 to 500 pps. Pulse

How to keep informed on the "with what" part of your business

AT YOUR FINGER TIPS, issue after issue, is one of your richest veins of job information – advertising. You might call it the "with what" type – which dovetails the "how" of the editorial pages. Easy to read, talking your language, geared specifically to the betterment of your business, this is the kind of practical data which may well help you do a job quicker, better – save your company money.

Each advertiser is obviously doing his level best to give you helpful information. By showing, through the advertising pages, how his product or service can benefit *you* and *your* company, he is taking *his* most efficient way toward a sale.

Add up all the advertisers and you've got a gold mine of current, on-the-job information. Yours for the reading are a wealth of data and facts on the very latest in products, services, tools . . . product developments, materials, processes, methods.

You, too, have a big stake in the advertising pages. Read them regularly, carefully to keep job-informed on the "with what" part of your business

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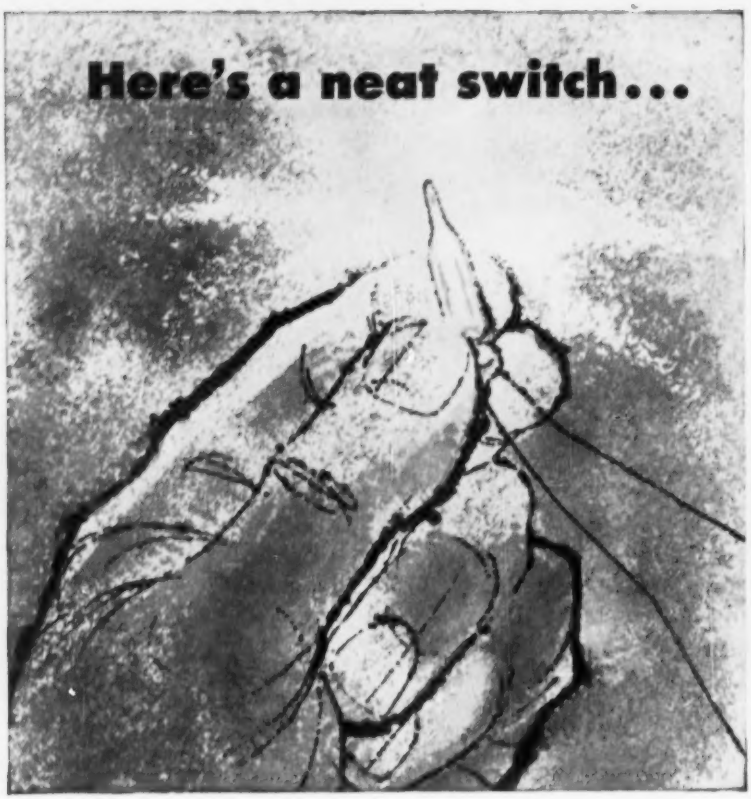

G-E GLOW LAMP PROVIDES NEW, LOW-COST CIRCUIT CONTROL

Before a G-E Glow Lamp starts, it is essentially an open circuit. When the lamp is biased to a point just below its starting voltage, the application of a pulse sufficient to raise the applied voltage to that which is required for starting causes the lamp to conduct—and the pulse to be transmitted to the other components. Apply reverse pulse and the lamp is extinguished, the circuit broken.

A Single G-E Glow Lamp May Serve As A:

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If you'd like more information on the amazing G-E Glow Lamps, send today for your free copy of the folder, "G-E Glow Lamps for Pilot and Indicator Use". Write: General Electric Co., Miniature Lamp Dept. E-4, Nela Park, Cleveland 12, Ohio.

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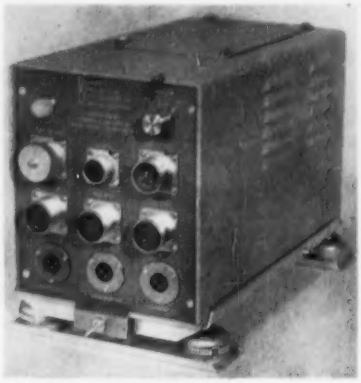
rise and fall time are both less than 1 μsec.

Equipment consists of a 15-kv d-c 0.15-ampere power supply; a 500-v focus-electrode supply; a 6-v 40-ampere klystron filament supply; three 150v 5-ampere focusing-magnet power supplies and a special modulator unit. **Circle P56 inside back cover.**



SIGNAL CONVERTER
for telemetering uses

DYNALYSIS DEVELOPMENT LABORATORIES, INC., 11941 Wilshire Blvd., Los Angeles 25, Calif. Model 4-1103 high-level instrument signal converter is a three-channel instrument designed for telemetering applications. The system converts signals from 400 cps transducers to 0-5 v d-c for telemetering inputs.

Conversion by a crystal diode demodulator eliminates all amplifiers from the signal circuits, assuring gain stability and zero stability. Frequency and voltage-regulated power is supplied to the transducers. Linearity of the demodulated signal output is 0.5 percent. **Circle P57 inside back cover.**

PROGRAMMER
multichannel device

PHOTOGRAPHIC PRODUCTS INC., 1000 No. Olive St., Anaheim, Calif. Type MPR-13 multichannel programmer provides up to 13 channels for any type of electrical programming, either of a repeat cycling or a random nature. It weighs only 3 lb 10 oz and meas-

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SO. NORWALK, CONN.

Mechanical Engineers (graduates BS and MS levels), Design Engineers, with or without formal degree, if qualified. Send complete resumé to Mr. Robert Martin, Dept. NMy-2, Wilson Ave., South Norwalk, Conn.

ST. PAUL, MINN.

Electronics Engineers, Mechanical Engineers, Electronic Design Engineers, Engineering Writers, Physicists, Mathematicians. Send complete resumé to Mr. R. K. Patterson, Dept. SMy-2, Univac Park, St. Paul 16, Minn.

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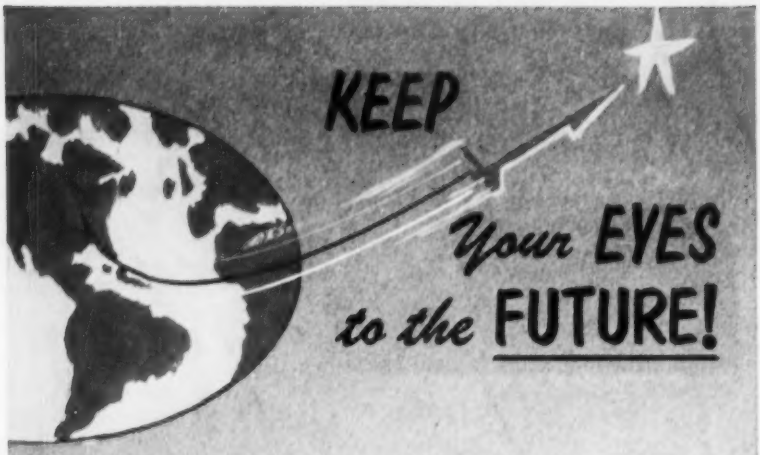

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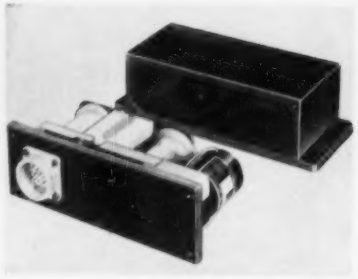
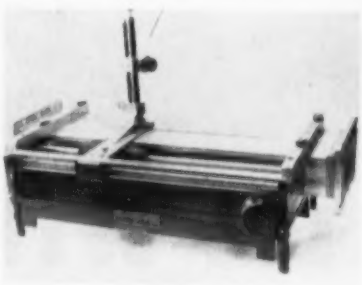


ures 2 in. by 3 in. by 6 in.

The device has an accuracy of the order of one part in approximately 50,000 even though it was designed to withstand the rigors of missile and aircraft usage. For utmost ruggedness it is manufactured to extremely close tolerances and is housed in a magnesium casting for a high degree of strength and resistance to shock and vibration without imposing a high weight penalty.

Additional information and prices are available. **Circle P58 inside back cover.**



SLOTTED LINE KIT
with universal carriage

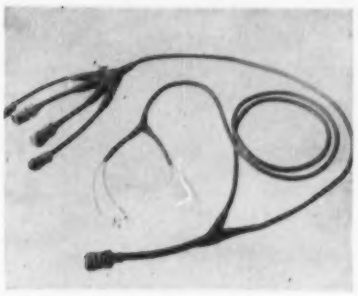
DIAMOND ANTENNA & MICROWAVE CORP., 7 North Ave., Wakefield, Mass. The D1C-6207 slotted lines and universal carriage are designed to provide a maximum of flexibility and accuracy for standing wave measurements in the 1.7 to 5.85-kmc region. The basic design consists of a rugged universal carriage which will accept interchangeable precision slotted sections in five different waveguide sizes (RG-104/U, 112/U, 48/U, 49/U and WR-229.)

Other features include a stationary spinner knob for vernier control of probe position, a push-button release control for rapid probe positioning, a scale vernier with zero reference at the plane of

the load flange and low residual vswr. **Circle P59 inside back cover.**

METAL FILM RESISTORS
in values through 1 megohm

WESTON ELECTRICAL INSTRUMENT CORP., Newark 12, N. J. The company's line of Vamistors (precision metal film resistors) is now available in resistance values up through one megohm. They have special resistance alloys fused into the inner surface of a moisture sealed ceramic tube in a dispersed form which renders the unit virtually impervious to the effects of abrasion, thermal shock and temporary overloads. In addition to having a temperature coefficient better than ±50 ppm per deg C, the Vamistor is noise free with excellent h-f performance. **Circle P60 inside back cover.**



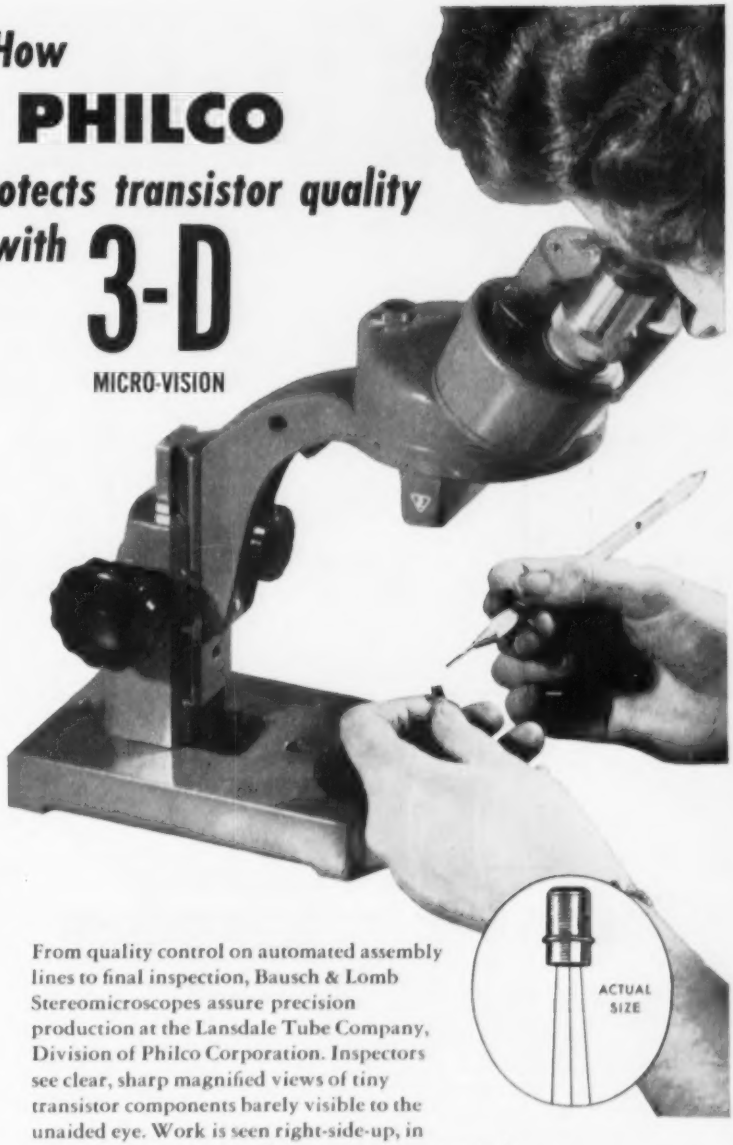
HARNESS ASSEMBLY
multi-breakout type

PACIFIC AUTOMATION PRODUCTS, INC., Los Angeles 17, Calif., has available engineered cable systems developed to meet the exact physical, electrical, environmental requirements of electronic systems, using neoprene-jacketed, multiconductor, custom-built cable. **Circle P61 inside back cover.**

TERMINALS
hermetic seal units

INTERNATIONAL RESISTANCE CO., 401 N. Broad St., Philadelphia 8, Pa., now offers miniature units for superior hermetic sealing of all types of electrical components. Known as type LT, the terminals are designed to meet all military

How PHILCO protects transistor quality with 3-D MICRO-VISION



From quality control on automated assembly lines to final inspection, Bausch & Lomb Stereomicroscopes assure precision production at the Lansdale Tube Company, Division of Philco Corporation. Inspectors see clear, sharp magnified views of tiny transistor components barely visible to the unaided eye. Work is seen right-side-up, in natural 3-dimensional relief. Freedom from eyestrain and discomfort increases efficiency. The result: precision standards that assure distortion-free sound in Philco-equipped transistor radios . . . speed and reliability in Philco-equipped computers.

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The heart of any ceramic capacitor or trimmer is its dielectric. In the ceramic dielectric are developed the electrical properties of the capacitor or trimmer. ERIE can provide any type of ceramic for dielectric use currently on the market. ERIE also makes many special ceramic dielectrics with unusual qualities, which are not available elsewhere.

Through constant research and development in its Ceramic Department, ERIE has maintained leadership in production of highest quality ceramic capacitors and trimmers, outstanding for their excellent stability and fidelity to specifications.

Quality Control in the production of ceramic bodies is of the utmost importance. At ERIE control starts with rigid testing of raw materials. Further control is maintained by testing at various stages throughout the production process.

ERIE is enlarging its facilities through the construction of a modern new ceramic plant at State College, Pa. Included in the new plant will be a thoroughly equipped research and testing laboratory and the most efficient production machinery, most of which has been designed by ERIE engineers.

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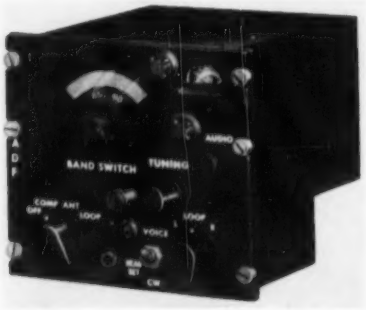
and commerical application requirements.

A body of molded Fluorocarbon plastic insulates the solder seal ring from the feed-through lead. Type LT's are unaffected by high humidity and are chemically inert to organic solvents, acids, alkalies, oils and fumes. They successfully overcome electrolysis under high d-c voltage, low corona breakdown voltage, low operating temperatures, inconsistent hermetic seals and similar limitations.

The terminals are specifically designed for requirements such as superior insulation resistance, zero moisture absorption, high arc-over resistance, wide temperature range, thermal shock and miniaturization. **Circle P62 inside back cover.**



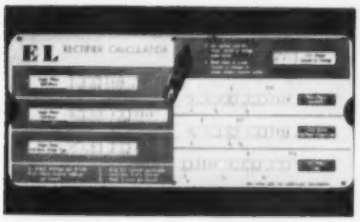
ADF
weighs less than 30 lb

THE MAGNAVOX CO., Fort Wayne 4, Ind., has designed a new lightweight automatic direction finder for use in aircraft. The complete system, including cables, weighs less than 30 lb, in contrast to the 80-lb weight of currently used equipment. The space requirement has been reduced by a factor of two-thirds.

The system includes a new loop antenna that is electrically interchangeable with the AS-313B loop commonly used. The loop has been streamlined to the extent that it protrudes only 2½ inches from the aircraft fuselage and readily permits flush mounting as required for supersonic aircraft.

The adf operates from any radio signal between 190 and 1,750 kc and automatically displays the compass bearing of the received

signal with respect to the aircraft heading. The radio set of the system also serves as a communications receiver. The system has satisfactorily passed rigid operational and environmental test programs. **Circle P63 inside back cover.**



SLIDE-RULE CALCULATOR
for circuit computing

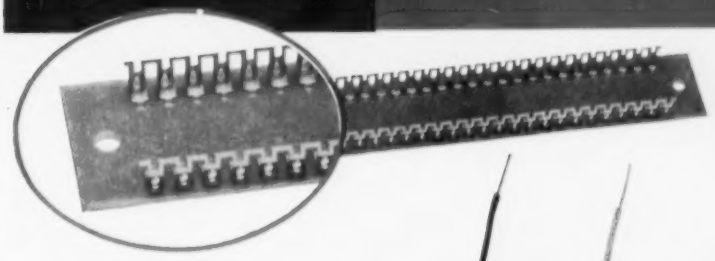
ELECTRONS, INC., 127 Sussex Ave., Newark, N. J., has available a convenient slide rule type calculator for computing rectifier and thyratron circuits. The calculator makes it possible to readily determine design parameters for all of the most frequently used circuits. To obtain one, send 25 cents for handling and mailing. **Circle P64 inside back cover.**

OSCILLOSCOPE
response d-c to 300 kc

ALLEN B. DUMONT LABORATORIES, INC., 750 Bloomfield Ave., Clifton, N. J. Type 403 is a sensitive commercial oscilloscope which features a full-scale amplitude-measuring range of 1 mv to 500 v in 17 steps and is capable of resolving a 20-μv signal. Frequency response extends from d-c to 300 kc. It is capable of reading directly microvolt outputs of strain gages, pressure pickups, accel-

another *New* concept in component packaging . . .

by ERIE Electro-Mechanical DIVISION



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- Automatic connector cutting
- Automatic component soldering

RESULTS:
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- Easier servicing

ERIE supplies the customers' complete component package: electronic components, molded plastic parts, metal stampings, and embossed wiring boards available from various ERIE divisions; as well as other components purchased from other manufacturers.

For more complete information regarding the ERIE 3976 Strip Package, and its practical application in the solution of your individual problems, write to Engineering Department, Electro-Mechanical Division, Erie Resistor Corporation.

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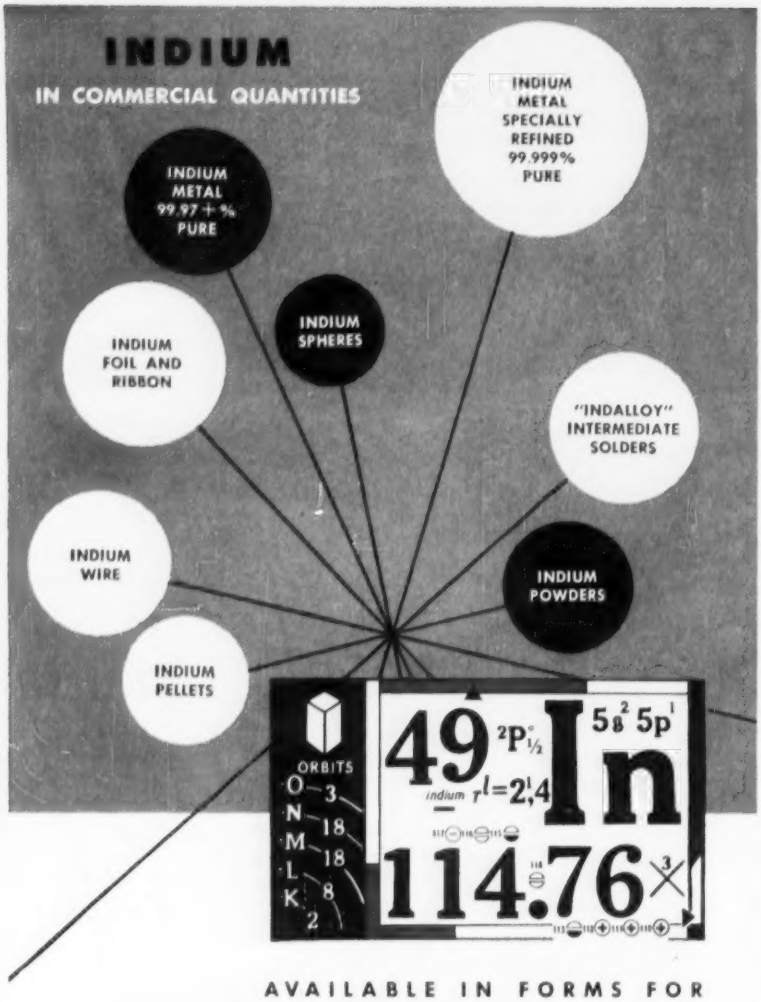

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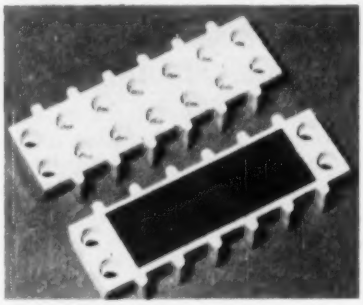
erometers and other transducers without the normally required preamplification.

Front panel controls permit selection of 19 accurately calibrated linear sweeps extending from 0.5 sec per cm to 0.5 μsec per cm. Overall accuracy of amplitude measurement on the Y-axis is within 5 percent of full scale, which includes errors in linearity of the amplifier, input attenuator and crt. **Circle P65 inside back cover.**



TERMINAL BLOCKS
have Mylar insulation strip

KULKA ELECTRIC MFG. CO., INC., 638 S. Fulton Ave., Mt. Vernon, N. Y. The Seal-Back terminal block features a Mylar insulation strip on the back completely covering and sealing in all counterbores having screw ends. Top view shows the exposed holes on back of regular terminal block; in the bottom view, all holes are covered except the two mounting holes at each end. This improvement eliminates the need for and use of separate insulation and marker strips, with extra pieces and extra handling. It also simplifies mounting and wiring work.

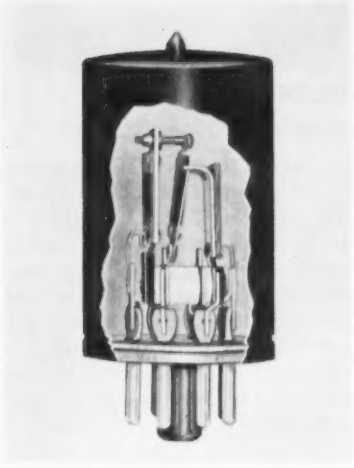
The Mylar used is one mil thick, plus 1½ mils for cement, making the overall thickness 2½ mils. Dielectric strength is 5,000 v. **Circle P66 inside back cover.**

IMAGE ORTHICON
for industrial applications

RADIO CORP. OF AMERICA, Harrison, N. J., has announced a tv camera tube designed especially for use in industrial and scientific-research tv applications involving ex-

tremely low light levels. Because the 6849 combines extremely high sensitivity with a spectral response approaching that of the eye, it can extend the range of human vision by amplifying low-intensity light images so that the eye can see details in the amplified images when they are brightly displayed on a tv picture tube.

When used in a standard tv system and with proper low-noise amplifiers, the 6849 can produce signal information with illumination on the photocathode as low as 0.00001 foot-candle. **Circle P67 inside back cover.**



THERMAL RELAY
with spdt contacts

CURTISS-WRIGHT CORP., 631 Central Ave., Carlstadt, N. J. The thermal memory relay is a bistable time-delay relay with spdt snap-action contacts. The relay is thermally operated, having two separate heater circuits. Each heater serves to transfer a movable arm from one contact to the other. The relay, being bistable, remains in either of the two contact positions until operated by the appropriate heater circuit. A time delay is associated with each operation.

Operating time of the unit is factory preset for either 20 or 30 seconds on both transfers. The relays are temperature compensated from −55 C to +100 C and have standard voltage ratings of 6.3, 26.5 or 117 v. Other voltages are available on request. Heater

RCA ELECTRONIC INSTRUMENTS

Get All Six Important Features

LV-14
DC NULL VOLTMETER
$345*
IMMEDIATE DELIVERY
Also available in rack mount

Here's a DC Null Voltmeter built to quality standards with six superior features:

- **Flexible input. It can be positive, negative, or neither side grounded.**
- **Calibrated voltage output for external recorder amplifier, sensitive laboratory galvanometer, etc.**
- **Simplicity of operation.**
- **Infinite impedance at null.**
- **Long-life Mercury battery.**
- **Both cabinet and rack models.**

Let our representative show you how RCA Precision Electronic Instruments can mean increased productivity. No obligation.

Just write to RCA Department S-46, Building 15-1, Camden, New Jersey.

*Price in U.S.A. f.o.b. Camden. Subject to change without notice.

SPECIFICATIONS

VOLTAGE RANGES:
0-10, 0-100, 100-200, 200-300, 300-400, 400-500, 500-600 volts DC. Positive, negative, or neither side grounded.

ABSOLUTE ACCURACY:
0.1% ± 10 millivolts between 0 and 10 volts. ± 100 millivolts between 10 and 600 volts.

RESOLUTION:
At least 5 millivolts between 0 and 10 volts. 50 millivolts between 10 and 600 volts.

INPUT IMPEDANCE:
Infinite at null. Greater than 2.5 megohms per volt at ¼ division off null.

POWER REQUIRED:
100-135 volts, 50-60 cycles, 24 watts.

RCA
RADIO CORPORATION OF AMERICA
COMMERCIAL ELECTRONIC PRODUCTS
CAMDEN, N. J.
In Canada: RCA VICTOR Company Ltd., Montreal

Instrument Engineering Representatives in Principal Cities

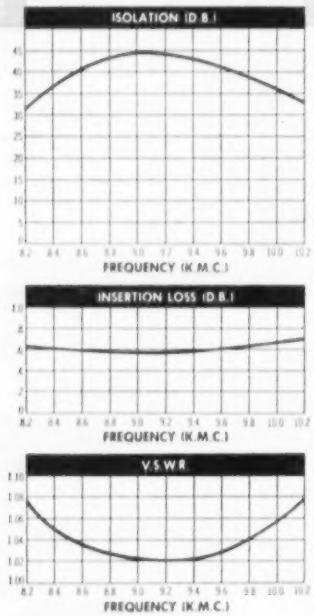
For additional information on all items on this page, use post card on last page.

A New Broad Band Kearfott FERRITE ISOLATOR for Laboratory Test Bench Use

Model W177-2C-1

Use this Ferrite Isolator in your microwave setup for maximum frequency stability.

Typical Performance Curves



CHECK THESE FEATURES:

Broad Band—Usable from 8.2 to 10.2 KMC

High Isolation—A minimum of 25 db over the band

Insertion Loss—Less than 1 db

Small & Compact—Only 2½ inches long—weighs only 1½ lbs.

Flanges—Cover type. Mates with UG39/U flanges. Will absorb up to 10 watts reflected power

Price—$135.00 each f.o.b., Van Nuys, Calif.

Delivery—From stock

Order—Model W177-2C-1

For custom-made isolators for specific radar & microwave application, you can depend on the skill of the Kearfott organization.

Kearfott, Western Division, has complete facilities for waveguide production, with qualified experts to assist in solving your problems. Let us help you.

For detailed information, ask for bulletins on new Ferrite Isolators and Radar Test sets.

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A SUBSIDIARY OF GPE
WESTERN DIVISION
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14844 OXNARD ST. · VAN NUYS, CALIF.

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Midwest Office: 188 W. Randolph St. Chicago, Ill.

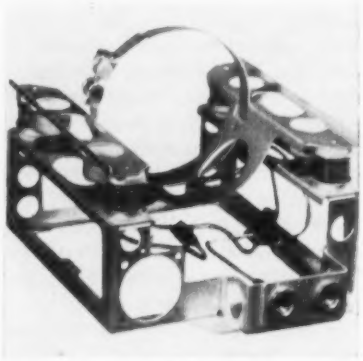
South Central Office: 6115 Denton Drive Dallas, Texas

Western Area Office: 253 Vinedo Ave. Pasadena, Calif.

power is 2.7 w for each heater. The relay has a life of at least 500,000 operations under average operating conditions. **Circle P68 inside back cover.**

SHOCK MACHINE
variable duration

ASSOCIATED TESTING LABORATORIES, INC., Clinton Road at Route 46, Caldwell, N. J., has available a shock machine designed, manufactured and calibrated in accordance with the test requirements of Specifications MIL-S-4456 and MIL-E-5272A, Procedure II. It features 150-pound test-load capacity with shock up to 60 g's. Arrangement of blocks allows for shock duration of 6.5, 11, 18, 24 and 32 milliseconds. Price is $2,350. **Circle P69 inside back cover.**



MOUNTING SYSTEM
for airborne applications

ROBINSON AVIATION, INC., Teterboro, N. J., has developed a Met-L-Flex center-of-gravity mounting

for a pressure ratio transmitter unit developed by Minneapolis-Honeywell for airborne applications. The specialized mounting system incorporates pressure and electrical connectors as part of the supporting structure of the mounting. This provides ease of installation and in effect combines the equipment and mounting into an integral package.

Constructed of aluminum and steel throughout, the model 1323 lightweight mounting system is unaffected by adverse operating conditions. Natural frequency of the model 1323 is between 6 to 11 cps while the amount of vibration isolation provided is approximately 90 percent at 40 cps. The system is readily adaptable to military applications. Modifications are available upon request. **Circle P70 inside back cover.**

CHECK-OUT SYSTEM
for automatic missiles

ELECTRO INSTRUMENTS, INC., 3794 Rosecrans, San Diego, Calif., has developed a new, automatic system for obtaining absolute d-c and a-c voltage and frequency values, as well as go/no-go checks. The system consists of three basic groups: program, control and measurement.

The program units include an input scanner, a programmer and computer, as well as the punch card memory and printer. The control unit consists of visual indicators and necessary circuitry for utilizing the measurement

profile of a
very special guy
...the Lenkurt
engineer

- Special, because with Lenkurt — leading specialist in telecommunications — he has found the challenges and inspirations, the responsibilities and recognition that add up to a truly satisfying career.
- Special, because he is planning and building the communications systems of tomorrow.
- Special, because at San Carlos, on the sunny San Francisco peninsula, he has found the ultimate in what is known the world over as "California living."

A few very special guys whose field of interest is communications will find these opportunities at Lenkurt most attractive:

Project Engineers — High level positions requiring at least 3 years professional history in communications equipment design, component development, or systems planning. Graduate study desirable.

Electronics Engineers — Knowledge of circuit design including amplifiers, oscillators, modulators, and regulators, utilizing tubes and transistors. Good background in test procedures and test equipment; BSEE with communications option desirable.

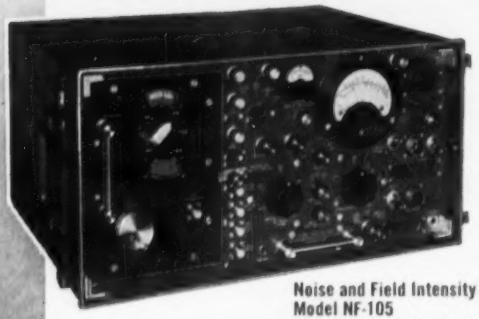
Assistant Electronics Engineers — Graduate engineers who have an interest in circuit analysis and experimentation and want to gain experience as members of an engineering team working on advanced development projects.

Lenkurt ELECTRIC
San Carlos 3, California

Please send your resumé to Dan Foster, Engineering Placement Manager

MEASURE NOISE AND FIELD INTENSITY FROM 150 KC TO 1000 MC— *WITH ONE METER!*

Quickly • Accurately • Reliably



Noise and Field Intensity Meter
Model NF-105
(Commercial Equivalent of AN/URM-7)

TA/NF-105: 150 KC-30MC

T1/NF-105: 20-200MC

T2/NF-105: 200-400MC

T3/NF-105: 400-1000MC

Empire Devices Noise and Field Intensity Meter Model NF-105 permits measurements of RF interference and field intensity over the entire frequency range from 150 kilocycles to 1000 megacycles. It is merely necessary to select one of four individual plug-in tuning units, depending on the frequency range desired. Tuning units are readily interchangeable...can be used with all Empire Devices Noise and Field Intensity Meters Model NF-105 now in the field.

Each of the four separate tuning units employs at least one RF amplifier stage with tuned input. Calibration for noise measurements is easily accomplished by means of the built-in impulse noise calibrator. With this instrument costly repetition of components common to all frequency ranges is eliminated because only the tuners need be changed. The same components...indicating circuits, calibrators, RF attenuators, detectors and audio amplifier... and power supplies...are used at all times.

Noise and Field Intensity Meter Model NF-105 is accurate and versatile, it may be used for measuring field intensity, RF interference, or as an ultra-sensitive VTVM. A complete line of accessories is available.

For complete performance data, send for Catalog No. N-356

NEW YORK—Digby 9-1240 • SYRACUSE—GRanit 4-7409 • PHILADELPHIA—SHerwood 7-5080 • BOSTON—TWinbrook 4-1955 • WASHINGTON, D. C.—DEcatur 2-8000 • ORLANDO, FLA.—ORlando 3-3524 • ATLANTA—CRdar 7-7801 • DETROIT—BRoadway 3-2900 • CLEVELAND—EVergreen 2-4114 • DAYTON—Fulton 8794 • CHICAGO—ESTebrook 9-2700 • DENVER—MAin 3-0343 • FORT WORTH—WAlnut 6-4444 • ALBUQUERQUE—Albuquerque 5-9632 • LOS ANGELES—REpublic 2-8103 • PALO ALTO—DAvenport 3-4455 • CANADA: MONTREAL—REgent 3-6502 • TORONTO—WAlnut 4-1226 • HALIFAX—HAlifax 4-6487 • EXPORT: NEW YORK—MUrray Hill 2-3760

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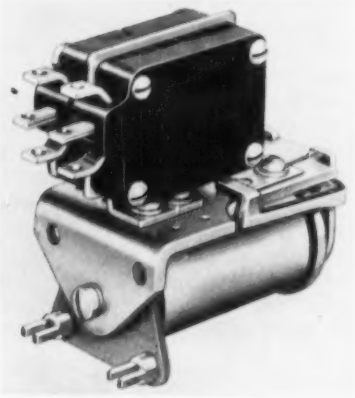
PRODUCTS CORPORATION
38-15 BELL BOULEVARD • BAYSIDE 61 • NEW YORK

manufacturers of
FIELD INTENSITY METERS • DISTORTION ANALYZERS • IMPULSE GENERATORS • COAXIAL ATTENUATORS • CRYSTAL MIXERS

units for monitoring junctions under test. Measurement units are the model 45P a-c/d-c digital voltmeter and the model 265P time interval meter.

Complete details on the system are available from the manufacturer. **Circle P71 inside back cover.**



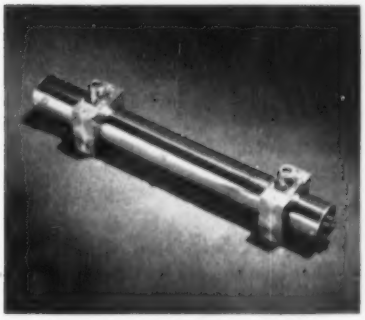
MINIATURE RELAY
with snap action

MAGNECRAFT ELECTRIC CO., 3350 W. Grand Ave., Chicago 51, Ill. Enclosed snap-action contact is a feature of the class 22SA open type relay. The new relay has contact rating of 10 amperes at 115 v a-c, noninductive load. It can be furnished with one snap action switch for spdt contacts or with two switches for dpdt contacts. It is also available with plug-in mounting.

The relay is furnished for d-c operation to 230 v; 60-cycle a-c to 440 v. Approximate overall dimensions are 2⅜ in. long, 1⅛ in. high and 1⅛ in. wide. **Circle P72 inside back cover.**

RUGGED, LIGHT TWT'S
cover 2 to 12-kmc range

GEISLER LABORATORIES, Menlo Park, Calif. Covering the range 2 to 12 kmc, a new line of eight traveling-wave tubes offers a specially designed, rugged, lightweight construction ranging from 5 to 7-lb total weight including a combined capsule and solenoid which not only permits size and weight reduction but also minimizes power



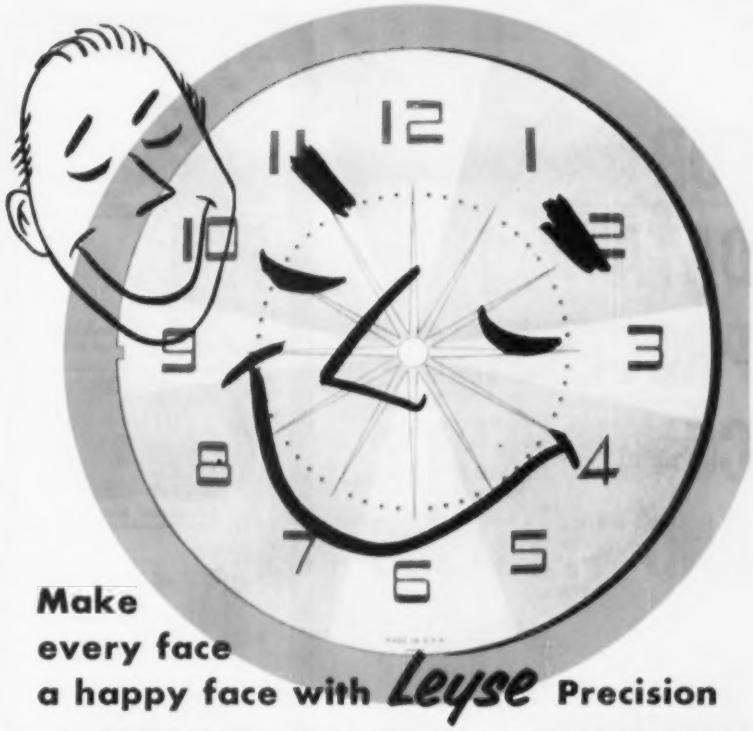
requirements for the solenoid.

Four of the tubes cover the 2 to 4-kmc range with power outputs from 10 to 30 dbm and small-signal gains from 28 to 34. Two of the tubes cover the band from 4 to 8 kmc with 10 and 30-dbm outputs and small-signal gains of 30 to 32. Two more cover the range 8.2 to 12.4 kmc with power outputs of 20 and 30 dbm and small-signal gains of 25 to 30 db.

A parallel series of eight tubes in the encapsulated, separate-solenoid type is available to cover the same operating specifications with total weights ranging from 10¾ lb to 20¾ lb over the range. **Circle P73 inside back cover.**

PREAMPLIFIER
a transistorized unit

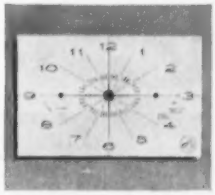
ALLEN B. DUMONT LABORATORIES, INC., 750 Bloomfield Ave., Clifton, N. J. Type 407 differential preamplifier is a transistorized unit offering a common-mode rejection ratio of a million to one. Designed for use with any general-purpose oscilloscope, the instrument amplifies low-level outputs from many transducers, such as strain gages and pressure pickups. It is com-

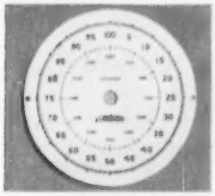


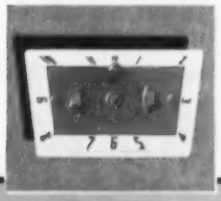
Make every face a happy face with *Leyse* Precision

LITHOGRAPHY on METALS

Designs for dials, instrument plates, bezels, panels and others reproduced with hairline register accuracy







Clean cut lettering and markings . . . close color register printing and embossing, free from blurs or smudges . . . plus, smooth over-all finishing and blanking with burr-free edges are what you can expect on your parts from Leyse.

Such lithography is but one of several methods employed by us in the production of decorative metals. Exacting letterpress and silk screen printing, along with a full range of finishing and production processes are also available.

Since 1903, America's leading industries have recognized Leyse's exacting workmanship and experience for producing quantity units with constant production economy and quality. Write for samples and send your blueprints for quotation. Your inquiry will receive our prompt attention.

LEYSE PRODUCTION FACILITIES INCLUDE:

- LITHOGRAPHING
- LETTERPRESS PRINTING
- SILK SCREENING
- ROLLER COATING
- SPRAYING
- SATIN FINISHING
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- HORIZONTAL BRUSH FINISHING
- SUNBURST FINISHING
- BRONZING
- EMBOSSING
- STAMPING
- FORMING
- SPINNING
- DRAWING
- DEBOSSING
- PUNCHING

Dials and Instrument Plates—Special Contract Products

Leyse ALUMINUM COMPANY

SINCE 1903

Dept. E • KEWAUNEE, WISCONSIN

For additional information on all items on this page, use post card on last page.

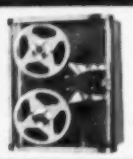
FOR DATA PROCESSING COMPONENTS AND SYSTEMS

SPECIFY POTTER

Potter instruments and systems are unexcelled in reliability, accuracy and flexibility. The equipment shown is typical of many more available as individual components or in integrated systems to meet specific requirements.

Write for brochure describing these and other Potter units, including special products. For detailed technical specifications on any of the Potter Products listed above, contact your Potter Representative or the factory.

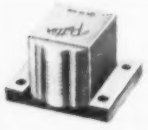
DATA-HANDLING EQUIPMENT



Digital Magnetic Tape Handlers

Perforated Tape Readers

"Quick Look" Recorders



Record-Playback Head Assemblies

Record-Playback Amplifiers

PRESET INTERVAL GENERATORS

Preset Interval and Delay Generators

HIGH SPEED ACCESS REGISTERS

Ten-Bit Parallel Output (Serial Input) Using Magnistors

Ten-Bit Serial Output (Parallel Input) Using Magnistors

Six-Bit Digital Comparator Using Magnistors

POTTER INSTRUMENT COMPANY, INC.
115 Cutter Mill Road Great Neck, L. I., N. Y.

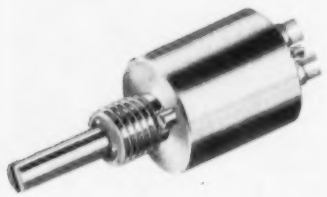
pletely self-contained and can be powered by ordinary flash-light batteries. The amplifier circuit, no larger than an ordinary playing card, amplifies input signal by a factor of 10. **Circle P74 inside back cover.**

FERRITE CORE CHOKES
with high Q

NATIONAL CO., 61 Sherman St., Malden 48, Mass., has announced a complete set of high-Q ferrite core choke coils offering 14 inductances from 150 μh to 1 mh in MIL-SPEC inductance values. The compact chokes are intended for use in networks and filters at frequencies from 50 to 1,500 kc and may also be used as resonant elements in i-f and r-f circuits.

Typical Q values are 142 at 240 kc and 182 at 460 kc for a 1-mh choke. Coil form length is $\frac{3}{8}$ in. with $1\frac{1}{2}$ in. pigtail leads. Overall diameters range from $\frac{7}{16}$ in. for the 10-mh choke to $\frac{3}{4}$ in. for 150 μh units.

The entire unit is impregnated with fungus-proof varnish per MIL-V173A to provide maximum protection under tropical heat and humidity conditions. **Circle P75 inside back cover.**



SUBMINIATURE POT
is ½ in. in diameter

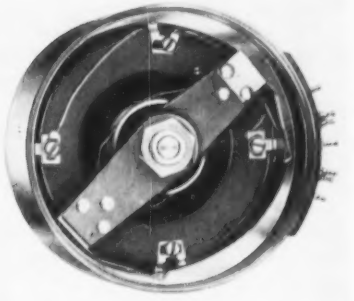
DEJUR - AMSCO CORP., 45 - 01 Northern Blvd., Long Island City 1, N. Y., has developed Model C-050, a precision ½-in. diameter potentiometer, without sacrificing design features found in larger types.

► **Features**—Included are a one-piece nickel-plated bronze case

and bearing, sealed silicone fiberglass cover with end-mounted terminals and O ring sealed shaft if required. Voltage breakdown between shaft and terminals is a full 1,000 v a-c.

Standard electrical rotation is 320 deg; mechanical rotation, 325 deg with stop or continuous 360 deg. Threaded bushing mounting designs are standard; servo or other mounting arrangements, on order. Standard shifts are 0.125 diameter ground and passivated stainless steel.

Technical literature is available on request. **Circle P76 inside back cover.**



SINE-COSINE POT

two separate voltage outputs

DEJUR-AMSCO CORP., 45-01 Northern Blvd., L. I., N. Y., has announced the model C-300, a high precision sine-cosine function potentiometer. Two separate voltage outputs may be obtained in this single three-in. enclosed unit. Independent brush contacts are mounted on a common shaft 90 deg apart to produce accurate sine and cosine voltages. Function accuracies of 1 percent are standard; function angle is 360 deg.

Technical literature is available on request. **Circle P77 inside back cover.**

VOLTAGE CONTROL

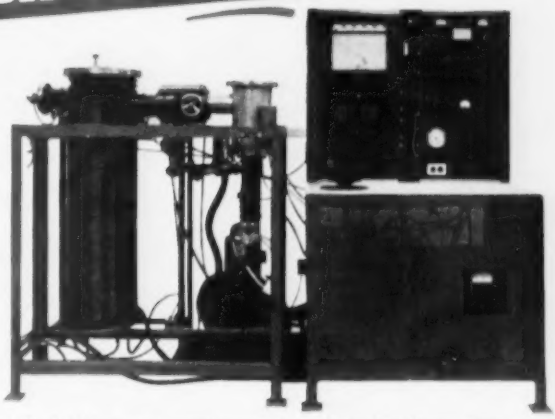
tests a-c aircraft equipment

OPAD ELECTRIC CO., 69 Murray St., New York 7, N. Y., has announced production of a new compact voltage control unit for testing a-c operated aircraft equipment and

Kinney®

VACUUM

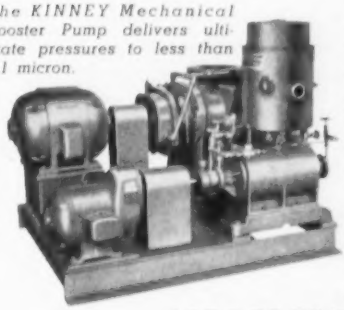
PRESCRIBED FOR YOUR PROJECT



A new tool for the researcher as well as manufacturers of transistors and semiconductors of all types . . . the standard KINNEY Crystal Growing Furnace.

Advances in High Vacuum equipment and technology are significant in many industries . . . but none more than in Electronics. And, KINNEY High Vacuum Pumps, Complete Systems and Component Parts, play a particularly important role in these advances . . . important to you from the standpoint of: *Product Improvement, Increased Production* and *Sound Economy.*

The KINNEY Mechanical Booster Pump delivers ultimate pressures to less than 0.1 micron.



Today, the KINNEY line represents the broadest selection of High Vacuum Pumps in the world. In performance, KINNEY Pumps deliver ultimate pressures to 0.10 micron. Thus, with KINNEY you can provide a *Prescription Answer to Your Vacuum Problem.*

What is true of Pumps is also true of new developments in complete High Vacuum Systems for research, pilot plant or full production.

WRITE: get the facts on KINNEY High Vacuum Pumps, Complete Systems, Valves, Gauges, etc.

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Kindly send me full information on new developments in

- ☐ KINNEY High Vacuum Pumps
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The 301 **PRINTED CIRCUIT**
"Trimmer"

For circuits with "no room to spare" the minute Model 301 plug-in trimming potentiometer packages pinpoint precision in thumbnail size.

SIZE: ½" x ½" x ¼"

WEIGHT: 2 grams maximum

STANDARD RESISTANCE VALUES: 10 ohms to 50K

ADJUSTMENT RATIO: 45:1

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Openings exist for highly qualified engineers

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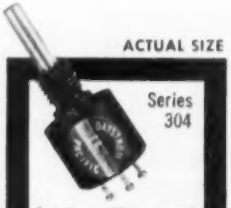
11150 La Grange Avenue, West Los Angeles, California

D for Daystrom—Daystrom for Dependability

ACTUAL SIZE



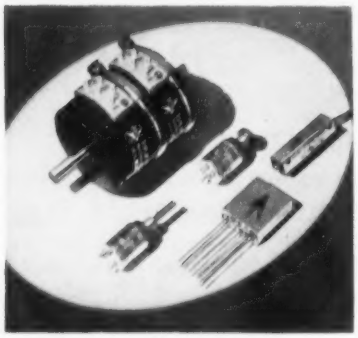
Series 304

One-turn, Wire-wound, Precision Potentiometer.

LOW COST
HIGH PERFORMANCE

components. The unit operates on 115-v 400-cycle single-phase power and provides a continuously adjustable output from zero to 115 v under a maximum load current of 15 amperes. Standard instrumentation includes a 3½-in. 21-reed ½-percent accuracy frequency meter and a 2-percent accurate a-c voltmeter.

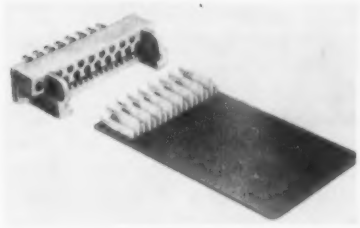
The unit weighs only 12 lb and is housed in a ventilated enclosure 12 in. wide by 6 in. deep by 7 in. high. A 6-ft rubber-covered input cord is supplied. **Circle P78 inside back cover.**



TINY COMPONENTS
meet applicable MIL-SPECS

ACE ELECTRONICS ASSOCIATES, INC., Somerville, Mass., has available some new subminiature components. Included are: a ½-in. Acepot precision wirewound pot with a 10 to 250,000-ohm resistance range, ±0.3-percent standard linearity; a high-temperature ½ in. X-500 Acepot which operates in the temperature range of −55 C to 150 C; a subminiature Acetrim trimmer with a resistance of 10 to 150,000 ohms; new nonlinear Acepots for sine-cosine and square-law functions featuring highly specialized design and precision construction; new Aceohm 35-turn trimmer with a resistance

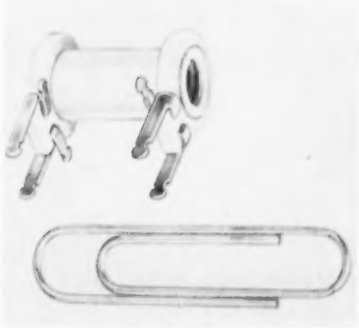
range of 10 to 50,000 ohms for high temperature or other severe conditions; and the hermetically sealed Acerelay, featuring ultra-compact size together with outstanding reliability for both power and dry circuit work. **Circle P79 inside back cover.**



P-C CONNECTOR
many contacts, small space

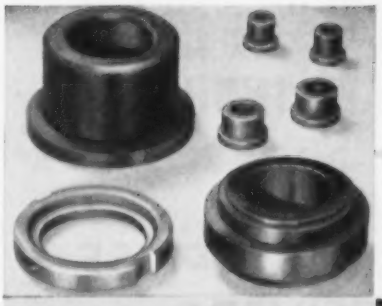
ELCO CORP., M St. below Erie Ave., Philadelphia 24, Pa., has introduced the 7000 series printed circuit Varicon connector. Contacts are staked directly into printed circuitry providing independent mechanical bond.

Current rating is 7 amperes; withstanding voltage (sea level), 2,000 v rms; contact resistance, 0.002 ohm (unchanged after thousands of matings). Spacing at 0.100 centers provides maximum number of contacts in minimum space. It is available in 17 contact units. Other sizes are under development. **Circle P80 inside back cover.**

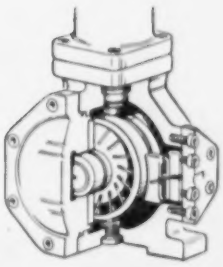


COIL FORMS
for printed circuits

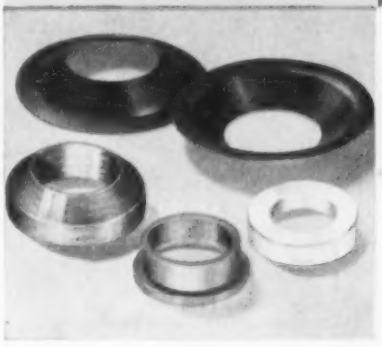
CAMBRIDGE THERMIONIC CORP., 445 Concord Ave., Cambridge 38, Mass., has developed new horizontal-mounted printed circuit coil forms. They come in a single

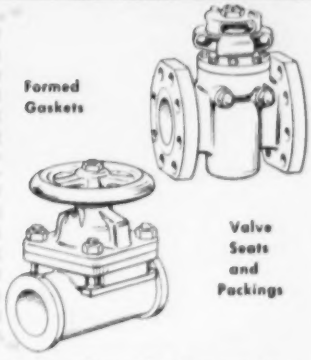


FOR:
Guide Bushings, Vanes and Wear Rings



HAVE YOU CONSIDERED THE IMPORTANT ADVANTAGES OF FILLED TEFLON*?





It has been definitely established that the value of Teflon can be considerably enhanced by the use of fillers in certain applications. Laboratory and field experience has demonstrated that the use of fillers permit Teflon to be more readily tailored to a wide variety of chemical, electrical and mechanical applications. Also, some mechanical properties can be improved. These include:

1) resistance to deformation under load
2) resistance to wear
3) thermal conductivity
4) compressive strength
5) hardness

By thus improving its properties, Teflon now offers even greater industrial potential. This is the reason filled Teflon has become an important item in the "John Crane" Chemlon® line of better Teflon products.

Chemlon is available with such fillers as glass fiber, carbon, graphite, copper and bronze, talc, calcium fluoride and other inorganic materials.

Tell us about your requirements. We'll tell you the advantages you can get from filled Chemlon. Request Bulletin T-104.

Crane Packing Company, 6402 Oakton Street, Morton Grove, Illinois, (Chicago Suburb). In Canada: Crane Packing Co., Ltd., Hamilton, Ont.

*DuPont Trademark

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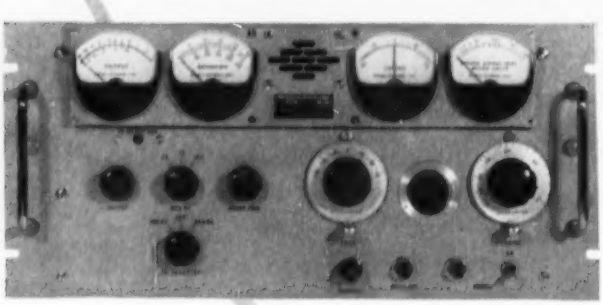
NEMS-CLARKE

SPECIAL PURPOSE RECEIVERS

NEMS-CLARKE special purpose receivers are designed to provide optimum performance for applications such as telemetering, guided-missile monitoring, radiosonde reception and numerous other applications where receivers of superior performance with high sensitivity and low noise are required.



TYPE 1401-A RECEIVER

SPECIFICATIONS

Type of Reception	FM/FM and PWM/FM
Frequency Range	216-245 Megacycles determined by plug-in crystals.
Noise Figure	Less than 7 db.
IF Bandwidth	Wide band—500 KC bandwidth at 3 db points. Attenuation +500 KC from center frequency greater than 60 db.
	Narrow band—100 KC bandwidth at 3 db points.
	Attenuation +250 KC from center frequency greater than 60 db.
Video Output	Sensitivity—0.16 volts peak-to-peak per KC of deviation.
	Frequency response within 3 db. AC coupled—10 CPS to 100 KC per second. Adjustable output control on front panel.
VU Meter in Video Output Circuit	Frequency response, flat over frequency range of 400 cycles to 80,000 cycles. Provided with front panel adjustable reference level control.
Spectrum Display Output	Provisions for connecting a 30 MC Spectrum Display Unit (NEMS-CLARKE, Inc., SDU-200)
Frequency Monitor Output	30 MC
Frequency Deviation Meter	Peak reading over frequency range from 400 to 80,000 CPS. Three scales 25, 75 and 150 KC.

NEMS-CLARKE

INCORPORATED

919 JESUP-BLAIR DRIVE

SILVER SPRING, MARYLAND

Write Dept. N-1 for further information

style, available in two lengths. Type 2270 is $\frac{8}{16}$ in. long overall and mounts on 0.500 in. by 0.200 in. mounting casters. The 2271 is $\frac{11}{16}$ in. long overall and mounts on 0.700 in. by 0.200 in. centers.

Both are made with $\frac{1}{4}$ in. o-d internally threaded ceramic tubing, grade L5 silicone impregnated. The units are slug tuned by a powdered-iron core. Both types have four solder terminals and two silicone fibreglass collars. The terminals for soldering are attached to the fibreglass collars and are so designed that coil leads can be attached to them separately from the printed circuitry or the leads may be attached to the circuitry with the terminals. **Circle P81 inside back cover.**

PHOSPHOR BLENDS
for tv picture tubes

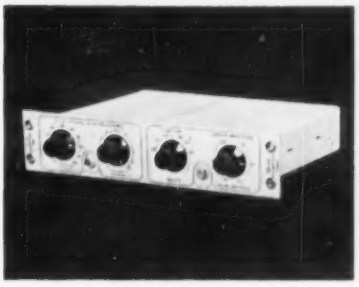
E. I. Du Pont de Nemours & Co., Wilmington, Del. Development and availability of new, brighter phosphor blends for tv picture tubes have been announced.

Designated P-4, the new phosphor blends are a light-body color type particularly suited for use in the manufacture of aluminized tv picture tubes. They are the brightest (at a given energy level) which the company has made available. **Circle P82 inside back cover.**

WIREWOUND RESISTOR
microminiature in size

General Resistance, Inc., 577 E. 156th St., New York 55, N. Y. The HA00 encapsulated wirewound resistor is $\frac{3}{32}$ in. in diameter by $\frac{7}{16}$ in. in length. The HA33 resistor shown for comparative purposes is $\frac{3}{8}$ in. in diameter by 1 in. in length. The microminiature re-

sistor is available in the resistance range of 0.1 ohm to 25,000 ohms. Standard tolerance is ±1 percent (with tolerances as low as 0.1 percent available on special order). Wattage rating is ⅛ w full load at 85 C. This resistor will meet the environmental conditions of MIL-R-93A. **Circle P83 inside back cover.**



PULSE GENERATOR
has new input standardizer

NAVIGATION COMPUTER CORP., 1621 Snyder Ave., Philadelphia 45, Pa., has incorporated a new standardized preamplifier input into the type 100B pulse generator in its transistorized pulse programming line of logic units. The unit generates standard 2.5-v system pulses and 25-v variable amplitude pulses of both polarities, with digitized pulse interval selection. The new input standardizer section will trigger on any waveform with a positive rise time of at least 1 μsec and 10 v amplitude. This provides additional versatility for system applications.

Complete technical description and applications are available. **Circle P84 inside back cover.**

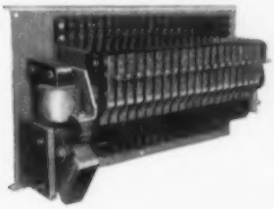
PARTS CLEANER
is specially purified

TECT, INC., Cortland and Erie St., Dumont, N. J., has announced Vythene-E, a highly refined grade of 1, 1, 1-Trichloroethane. Because of the low percentage of residue in the product, Vythene-E is finding wide acceptance in special uses, such as highly sensitive electronic parts. Recent tests have shown it to be an excellent cleaner for precious metal contacts used in radio and tv transmitting.

Vythene-E is approximately 20

NEW EAGLE STEP SWITCH SIMPLIFIES CIRCUIT SEQUENCING

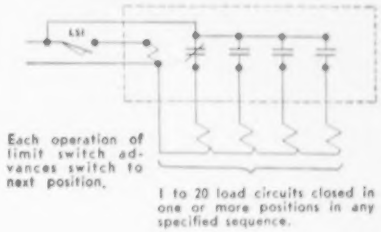
. . . for machine tools, presses, conveyors, processes



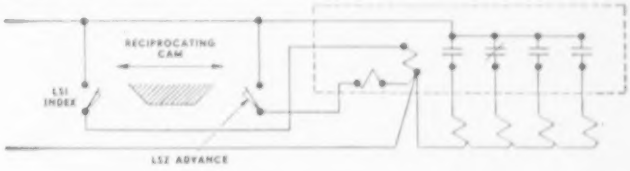
These 3 basic ideas are yours

for simplified interlocking or sequencing of multiple load circuits. Any and all three will eliminate many other electrical components, and cut your initial cost.

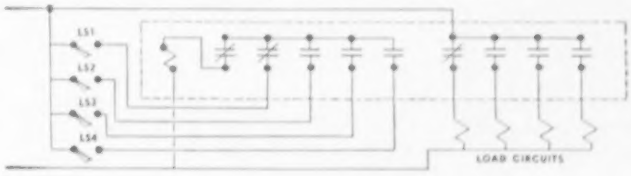
Operating load circuits in sequence:
A limit switch on a machine or indexing device closes and opens upon each operation to advance the Eagle step switch. Or a timer may be used to operate each load circuit for a predetermined time.


LS1
Each operation of limit switch advances switch to next position.
1 to 20 load circuits closed in one or more positions in any specified sequence.

Interlock sequence: *Two limit switches* are operated alternately. This provides a safety feature. It insures that the movement of the machine has been completed before the Eagle step switch advances.



Interlock sequence with several limit switches: Each limit switch advances the Eagle step switch one position. Switches must operate in sequence or the step switch won't advance.



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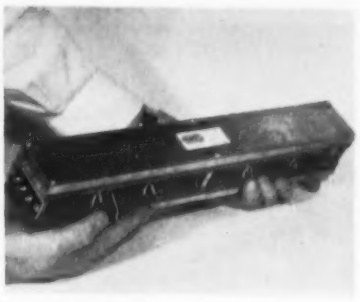
times less toxic than carbon tetrachloride and has no flash point. In addition, the product is highly stabilized to all metals including aluminum and can be successfully reclaimed by distillation in the company's automatic Teeter-Still. It is available in drum quantities. **Circle P85 inside back cover.**



DELAY LINE
in open type housing

UNDERWOOD CORP., Electronic Computer Div., 35-10 36th Ave., Long Island City 6, N. Y. Type 4D92 lumped-parameter electrical delay lines possess a total delay of 300 μsec $\pm$ 1 percent with taps available at every one μsec or any multiple thereof. They feature a maximum attenuation of only 4 db and a delay-to-rise time ratio of 75 to 1 over their entire length. Maximum rise time is 4.0 μsec while impedance is 1,000 ohms $\pm$ 5 percent. Use of the ferrite core construction enables the 4D92 to be efficiently packaged in an open-type housing measuring only 16$\frac{5}{8}$ in. by 2$\frac{1}{2}$ in. by 2$\frac{1}{8}$ in. **Circle P86 inside back cover.**

MAGNETIC HEADS
for use in computers

THOMAS A. EDISON INDUSTRIES, Instrument Div., West Orange, N. J., has developed a new series of custom designed magnetic recording heads for use in computers in aircraft and industrial applications. Available in both single and multihead styles with up to 15 tracks, these heads are specially laminated for better h-f response. Track positions and straightness are held to extreme accuracies. Impedance between tracks is only $\pm$10 percent on standard units,

±5 percent on custom units. **Circle P87 inside back cover.**

READ-OUT TUBE
now in volume production

BURROUGHS CORP., Electronic Tube Division, Plainfield, N. J. The Nixie read-out tube is a small, low-cost electron device which converts electronic signals directly to readable characters. It contains all the numeric digits, any one of which can be selected and displayed in a common viewing area. It can be triggered by beam switching tubes or any suitable voltage source requiring approximately ¼ w.

Applications for the Nixie tube include computer read-out, industrial control, electronic instrumentation, military electronic control and channel selectors. **Circle P88 inside back cover.**

V-T VOLTMETER
low-frequency unit

MILLIVAC INSTRUMENT CORP., P. O. Box 997, Schenectady, N. Y. The

SEALECTRO "PRESS-FIT"*

TEFLON† TERMINALS

Tried-tested-proven! In countless severe-service assemblies such as guided missiles, jet planes, radar, communications receivers, electronic computers, etc. Insist on Sealectro "Press-Fit" terminals—the **original** and **genuine** press-fitted terminals—if you seek to

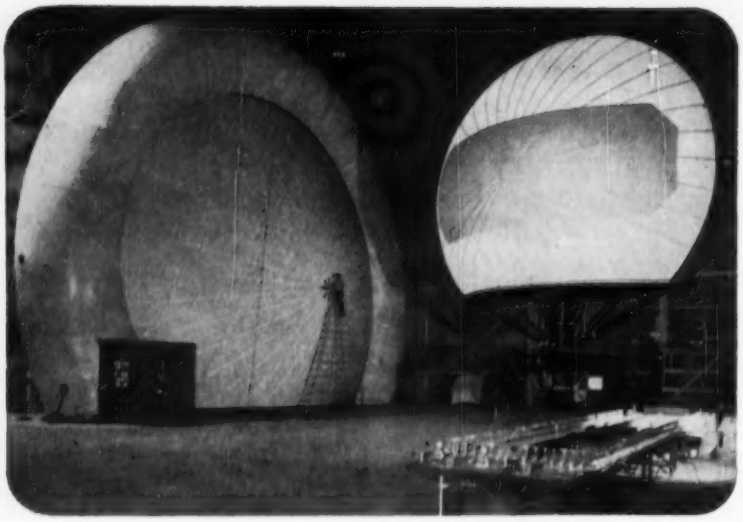
- **Eliminate** brittle insulation and fussy sealing.
- **Eliminate** threads, nuts, washers, lock-washers, and other hardware, reducing labor to a minimum.
- **Eliminate** carbonization and arcing by minimizing surface-moisture accumulation.
- **Eliminate** voltage breakdowns with an extra-generous safety factor.
- **Eliminate** thermal, chemical, mechanical, climatic, fungus and other problems.

And Sealectro offers the outstanding selection—over 600 standard types—miniature and sub-miniature stand-offs and feed thrus; breakaway connectors; test point jacks—in a choice of eight RETMA code colors.

SAMPLES AND LITERATURE . . . Write on business stationery for "Press-Fit" samples and literature. Let us collaborate on your terminal requirements.

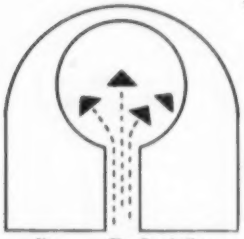
*Trademark of the original Teflon terminal manufacturer
†Reg. Trademark, E. I. Du Pont de Nemours & Co.

Sealectro CORPORATION
610 Fayette Avenue, Mamaroneck, N. Y.



Exciting News About The Revolutionary "PARABALLOON"

The Original Paraballoon was mounted on a metal support. Only the antenna and balloon protector were air supported.



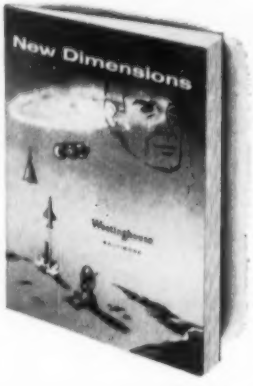
Now . . . The Paraballoon is completely air supported — even lighter and more easily erected. Air supported structures as large as 65 ft. in diameter and over 100 ft. high are under study.

Westinghouse - Baltimore Engineers Have Adapted This Radical Antenna For Use In Scatter Communications

Just a few short months after the development of the Paraballoon by Westinghouse-Baltimore engineers, these same engineers have developed an entirely new application for it . . . which promises to revolutionize "over-the-horizon" scatter communications. The new Paraballoon application is just one more example of the pioneering leadership synonymous with the name Westinghouse-Baltimore.

From Westinghouse-Baltimore comes an exciting new book every engineer's family should read.

"New Dimensions"—a book of engineering career opportunities—tells you what you and your family want to know about job opportunities, growth possibilities, attractive benefits and a rich, full life in a progressive community.



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Please indicate your degree, year of graduation, and field of interest.

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SINCE 1886

MV-02B a-c vacuum-tube voltmeter has a frequency range of 2 cps to 250 kc and a full scale voltage range of 3 mv to 1 kv. The instrument is equipped with galvanometer-attenuation switch which makes it possible to obtain fast needle response on all measurements above 20 cps, while the necessary slow response is being maintained between 2 cps and 20 cps.

High accuracy and calibration stability are obtained through a fully electronically regulated plate current supply and individual calibration controls for all 12 ranges of the instrument. **Circle P89 inside back cover.**

R-F COAX CONNECTOR
eliminates extra switching

TRU-CONNECTOR CORP., 416 Union St., Lynn, Mass. Now available is a new r-f coaxial connecter which eliminates the need for extra switching in many r-f and video applications. Known as the TRU-862, this QDS (quick-disconnect small) connector incorporates a spdt switch without increasing the size of the connector. **Circle P90 inside back cover.**

NETWORK SWITCHER
handles high voltages

BOMAC LABORATORIES, INC., Salem Road, Beverly, Mass. The BL-148 is a high-voltage, hermetically sealed, armature type relay developed for switching radar pulse-

forming networks. It consists of one set of spst h-v switch elements and two sets of l-v spst elements, simultaneously operated from a 26.5 v d-c source.

The h-v elements are rated to handle 7,500 v (15,000 v test) and 90 amperes (peak) 3.0 amperes rms; the low voltage elements are designed to safely handle 1,000 v and 1.6 amperes d-c. Switching time is less than 0.1 sec. The switch portion is immersed in Dow-Corning Silicone oil during h-v operation.

The BL-148 weighs 3.6 oz and has overall outline dimensions of 3 in. (maximum) length and 1⅛ in. (maximum) diameter. **Circle P91 inside back cover.**

TV CAMERA TUBES
with low image persistence

NUCLEONIC PRODUCTS CO., Los Angeles, Calif., has available three new Resistron (Vidicon type) tv camera tubes. Type 135 is only ½ in. in diameter and 3½ in. long. It features 300-line resolution and is designed for use in miniature cameras. Type 255 is a standard size which features 600-line resolution, excellent sensitivity, good edge focus and low flare. Type 350 is a special large size capable of 1,000-line resolution. This tube has a diameter of 1⅜ in. and is slightly larger than type 255.

Also available is a new Vidicon

Acetrim* sub-miniature
precision TRIMMERS
for PRINTED CIRCUITS

Here is another new development from Ace . . . sub-miniature precision wire-wound trimmers especially for printed circuits. Designed and produced to meet your tightest specifications, the new Acetrim has flat or round tabs to facilitate production assembly. Just plug into printed circuit board, secure, and dip solder.

Featuring

- ½" size
- 10 ohms to 150 K
- weight ¼ ounce
- power 2 w. @ 60° C. max.
- temperature to 125° C.
- sealed, moistureproofed, anti-fungus treated
- withstands severe shock, vibration, acceleration
- meets applicable Military specs

Ace delivers reliability

Modern mass production techniques assure delivery to meet your schedules . . . rigid quality controls assure highest standards of performance-reliability.

Acetrim — *write for Technical Data Unit #563.*

Acepot — ½" sub-miniature precision wire-wound linear potentiometers from 10 ohms to 250K. ±.3% standard. *Write for Technical Data Unit #564.*

Nonlinear Acepot — precision wire-wound nonlinear potentiometers for sine-cosine and square-law functions and other applications. High resolution, close conformity. *Write for Technical Data Unit #572.*

X-500 Acepot — ½" sub-miniature precision potentiometers for extreme temperatures of —55° C. to 150° C. 10 ohms to 250K. *Write for Technical Data Unit #571.*

*trademarks applied for

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For additional information on all items on this page, use post card on last page.

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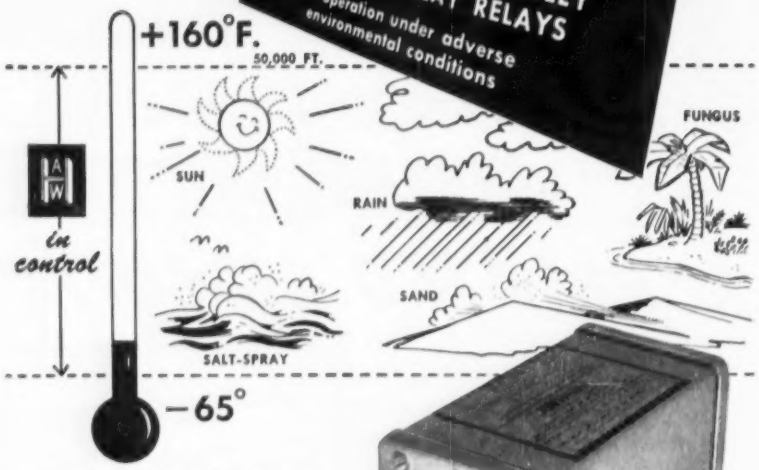
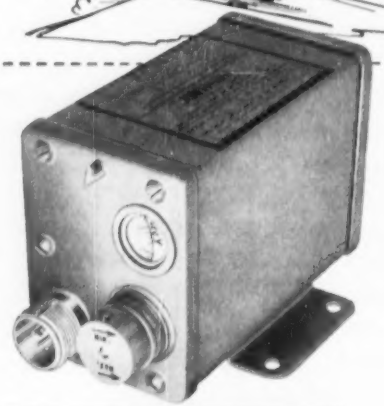
Do you require BOTH? NO PROBLEM for the

A. W. HAYDON Company

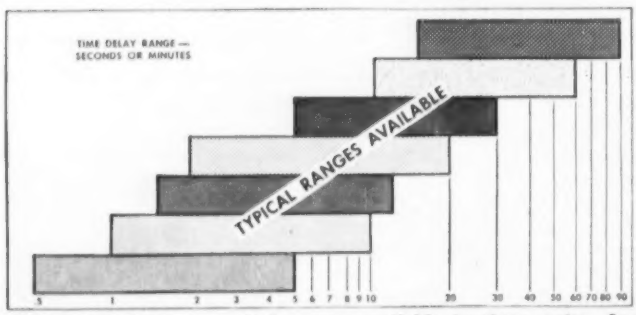
The A. W. Haydon Co. offers a complete line of ADJUSTABLE — HERMETICALLY SEALED TIME DELAY RELAYS for operation under adverse environmental conditions





Illustrated above are a few of the many environmental conditions which these compact timers are designed to withstand. More rigid requirements frequently can be met upon special consideration.

Bulletin AWH TD401 Describes
6400 Series — DC units
11400 Series — AC units
24300 Series — 400 cycle units
Nominal Range of Adjustment: 8-1
Timers supplied with:
AN connector
Hermetic Adjusting Knob
Glass Window and Calibrated Dial



Shown in the chart are typical ranges available in these units. Special ranges frequently can be supplied to meet specific requirements.

A W

Write for Bulletin AWH TD401

The A. W. HAYDON Company

235 NORTH ELM STREET, WATERBURY 20, CONNECTICUT

Design and Manufacture of Electro-Mechanical Timing Devices

PREFERRED WHERE PERFORMANCE IS PARAMOUNT.

type tube sensitive in the infrared region from 8,000 to 22,000 Angstroms. **Circle P92 inside back cover.**

POWER SUPPLIES
subchassis type

THE REFLECTONE CORP., Stamford, Conn., has introduced two new electronic subchassis power supplies. They are similar, but have different output voltage ranges. Output for model PS-S150 is 150 v, 150 ma d-c, 6.3 v, 6 amperes a-c; for model PS-S300, 300 v d-c.

Input is 115 v, 60 cps. The d-c regulation is 0.5 percent for 10-percent lines, 1.0 percent for no-load to full-load. Construction is rugged and the units are easily mounted on the chassis with four screws. Easy adjustment can be made for any operating voltage within the limits specified. **Circle P93 inside back cover.**

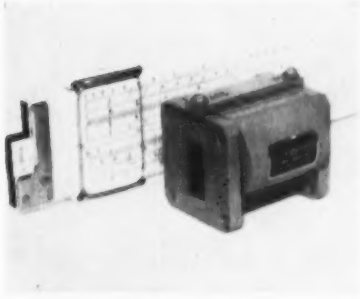
BAND PASS NETWORK
low insertion loss featured

ORTHO FILTER CORP., 196 Albion Ave., Paterson 2, N. J. The series

2090 unIFilter is a band-pass interstage network featuring exceptional frequency attenuation characteristics with low insertion loss. Units are available with bandwidths ranging from 6 kc to 35 kc at a center frequency of 455 kc. Typical adjacent channel rejection is 85 db at ±40 kc. The unIFilter series includes types suitable for use in triode or pentode mixer plate circuits eliminating the need for additional selectivity.

High stage gain is achieved through the combination of low pass band transmission loss and high input and output impedance. Field tests indicate no observable ringing is introduced by the incorporation of the unIFilter in standard receivers.

Other available center frequencies range from 50 kc to 40 mc. **Circle P94 inside back cover.**



LOAD ISOLATOR
for X-band radar

LITTON INDUSTRIES, 5873 Rodeo Road, Los Angeles 16, Calif. Model X10/S132 ferrite load isolator is especially designed for new X-band radar where space and weight are at a premium. Weighing only 1 lb it provides a minimum of 10-db isolation over 8,500 to 9,600 mc with a maximum of 0.6-db insertion loss over the whole band. Isolation in the middle of the band is approximately 13 db.

The isolator is only 2 in. long and 2 in. wide. Vswr is 1.15 maximum. Designed to operate at 10-kw peak and 10-w average power, the isolator is also available for use at higher power.

Utilizing the resonance absorption characteristics of ferrites,

LOOK TO TOBE FOR PROGRESS

electronic
RF
filters

Medium power, 11 circuit RF filter, designed to operate in the range of −55°C to +100°C.

As specialists in the design and manufacture of RF filters since 1922, TOBE has accumulated a vast wealth of data covering filtering techniques. When it comes to filtering problems, TOBE can solve them.

TOBE Filterettes in both single and multiple circuits, are available in several hundred standard designs to meet any conceivable application. All types are engineered to operate under the most severe environmental conditions.

For further data or engineering aid, write TOBE DEUTSCHMANN Corporation, Norwood, Mass.

- *Tobe Exclusives:*
- Miniaturization with maximum quality.
- Guaranteed attenuation characteristics under full-load operating conditions.
- Current ratings up to 350 amps., AC and DC voltage ratings up to 5000 volts.
- Maximum insertion loss at all frequencies from 14 kc to 15,000 mc.
- Each type available in a variety of mounting styles.

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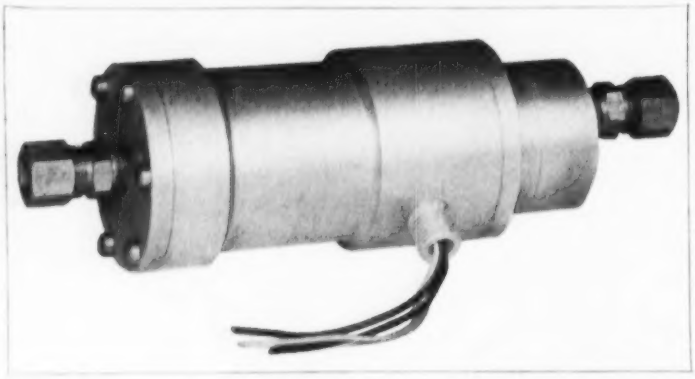
TOBE DEUTSCHMANN • CAPACITOR PIONEERS SINCE 1922

for airborne equipment

Dynacor

THE PUMP THAT CAN'T LEAK



Leak-proof, Light-weight, Needs No Lubrication

DYNACOR, 400 cycle, leak-proof pumps can cut your maintenance costs by as much as 90%. Compactly constructed without seals or stuffing boxes they positively prevent costly fluid losses. No lubrication is required.

DYNACOR pumps can eliminate over-heating of expensive airborne electronic equipment. Lightweight and space saving, these pumps are ideal for circulation of coolants in airborne radar and other heat-generating electronic equipment. Other applications include missile launching apparatus and fire control mechanisms. DYNACOR pumps are especially suitable for pumping flammable liquids.

DYNACOR pumps can be supplied in several models. Of these, the Model G includes an expansion chamber. This feature plus the unitized construction prevents leakage at any altitude or temperature. In this model the rotor and stator are encased in a suitable metal cartridge, which can be changed readily without special tools.

The Model GG is a compact unit with its rotor and stator immersed in the fluid being pumped. Centrifugal, gear and vane types are available for special applications.

DYNACOR pumps are available for single or three-phase AC input. 1/20 horsepower motor draws approximately 1 ampere. Other power inputs can be supplied on special order.

Efficient over a wide temperature range, DYNACOR pumps operate effectively from minus 60° F to plus 165° F.

NO SEALS NO STUFFING BOXES

MINIMUM MAINTENANCE

Write today for literature on unique DYNACOR pumps

Applied Dynamics CORPORATION

32 NORTH MAIN STREET NATICK, MASSACHUSETTS

the isolator offers a small and light solution to long-lines and other magnetron loading problems caused by lengthy transmission lines or excessive vswr's. **Circle P95 inside back cover.**

FREQUENCY METER
allows 20-channel servicing

ALLEN B. DUMONT LABORATORIES, INC., 750 Bloomfield Ave., Clifton, N. J., has developed a frequency meter capable of servicing multiple transmitter installations operating on from one to twenty channels in mobile radio communications systems.

Type 5890-A is portable and features transistorized circuitry. It can be utilized with any transmitter operating within the complete land-mobile services' frequency bands—25 mc to 470 mc.

The case housing the instrument measures 8 in. wide by 7 in. deep by 7 in. high. It weighs only 8 lb. Further information is available from the company. **Circle P96 inside back cover.**

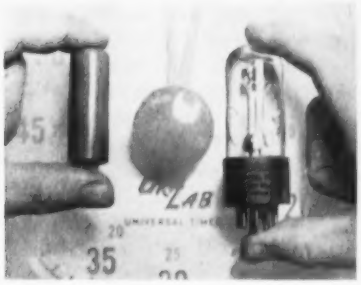
MOTOR CONTROLLER
for accurate acceleration

GERALD K. HELLER CO., 1819 Industrial Road, Los Vegas, Nevada. The CX25 electronic controller provides accurate acceleration and speed control of shunt-wound d-c motors ranging from 1/50th to ¼ hp. Using the acceleration control, the motor can be brought up to any speed from 1 to 2,200 rpm in a short time or gradually over a half-minute interval. This fea-

ture has wide application and is especially important in the winding of fine wire and filaments that break readily when subject to sudden tension.

The fine-speed adjustment works in conjunction with the coarse-speed control. Motor speed may be accurately and steplessly varied through a 220-rpm range with 270 degrees of rotation of the fine-speed control pot.

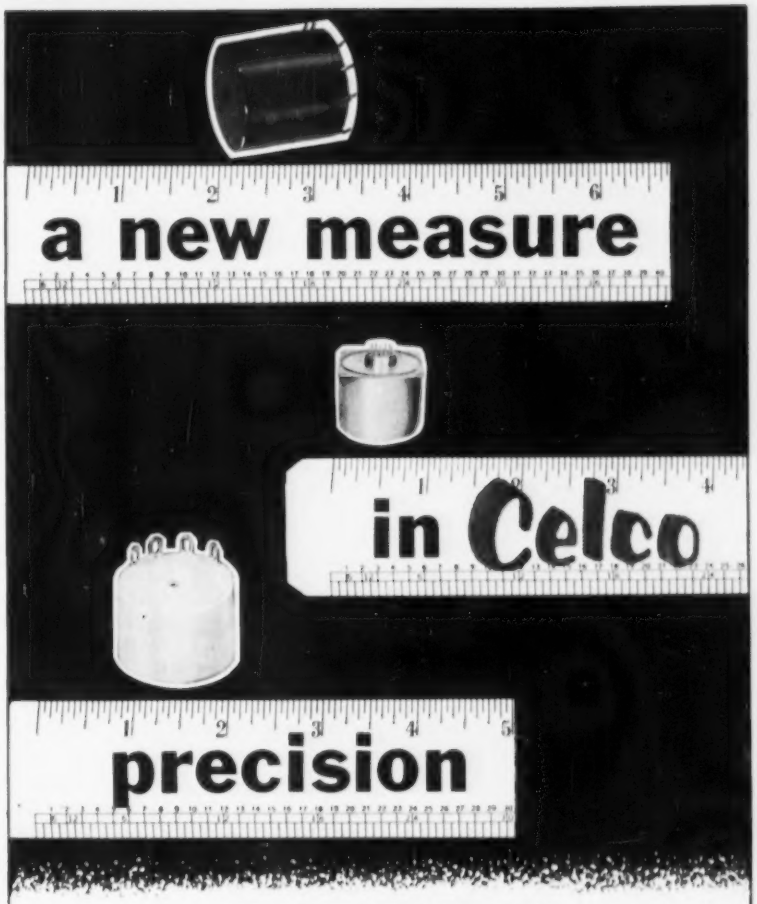
The controller uses one C3J thyratron tube. This automatically increases voltage to compensate for additional loading of the motor armature. Thus the speed of the motor is maintained with good regulation. The CX25 is available for use in original equipment. **Circle P97 inside back cover.**



DELAY RELAY
new miniature type

THOMAS A. EDISON INDUSTRIES, West Orange, N. J., has developed a new miniature thermal delay relay (shown at the left). This vibration resistant unit is specifically designed for applications in both missiles and jet aircraft. Among its many design features are: virtual elimination of contact chatter up to 1,500 cps at 10 g's; no resonance to 500 cps; good ambient compensation between −65 C and +85 C—operation at higher temperatures when necessary; contacts rated for 1 ampere at 27.5 v d-c or 3 amperes at 115 v a-c and extra-rigid construction for exceptionally high contact pressure.

Seated height is 2 in.; diameter, ¾ in.; weight, 1 oz maximum. Further information is available from the company. **Circle P98 inside back cover.**



TOROIDAL COMPONENTS

Whether it's a complex 10 winding magnetic amplifier or a simple choke . . . at Celco each toroid is precision-made. New core materials are used in Toroidal magnetic amplifiers, reactors and transformers to achieve maximum performance.

At Celco, the proper matching of cores, winding, handling, impregnation, encapsulation and electrical history of the final assembly is carefully controlled to maintain the original design characteristics.

Our years of design, development, and production know-how are available for application to your specific **TOROIDAL** problems.

* *For immediate attention, call* **DAvis 7-1123** *— or write today.*

Celco

Constantine Engineering Laboratories Co.

MAHWAH, NEW JERSEY

New Literature

Linear Scale A-C Ammeter. Beckman/Helipot Corp., Newport Beach, Calif. Details of the company's newly developed linear scale a-c ammeter are given in data sheet 839. Easily read linear scales plus high accuracy are two of the features stressed.

The dial markings on the ammeter described are evenly spaced, thus eliminating crowded divisions at one end of the scale. The deflection of the needle is always directly proportional to the amperage.

The data sheet points out that accurate performance is assured by a series of rigid tests which qualified the unit for use in military aircraft. **Circle L1 inside back cover.**

Silicon Rectifiers. Sarkes Tarzian, Inc., Rectifier Division, 415 N. College Ave., Bloomington, Ind. Design Notes No. 15 covers the SM series of silicon rectifiers which provide a voltage range from 800 to 2,800 v peak inverse and current ratings that range from 325 to 450 ma.

The compact package design for the power rating described makes the SM series ideal for use in transmitter and other types of h-v medium current power supplies. **Circle L2 inside back cover.**

Speed Reducers. Western Gear Corp., P.O. Box 182, Lynwood, Calif. Bulletin 5616 covers a new line of double and triple-reduction speed reducers, with ratings up to 50hp and efficiency ranges from 97 percent or better. The speed reducers described bear the trade name "Strait Line" and are immediately available in all models. **Circle L3 inside back cover.**

Converters and Inverters. Electronic Research Associates, Inc., 67 E. Center St., Nutley 10, N. J., has available two new literature pieces covering the line of transistorized semiconductor converters and inverters. Available is a two-color catalog sheet listing full technical details and pricing information covering d-c to d-c converters and d-c to a-c inverters.

Also available is a seven-page technical bulletin which provides operational characteristics, design data and technical description on these converter and inverter units. **Circle L4 inside back cover.**

Time Delay Relays. Elastic Stop Nut Corp. of America, AGA Division, Elizabeth, N. J., has issued a four-page illustrated bulletin, SR-5R, containing selection information for hermetically sealed Agastat time delay relay models whose light weight and reduced dimensions make them specially suitable for aircraft applications.

The bulletin includes a selection chart which gives terminal type, contact and terminal arrangement, and dimensions for the five basic SF type Agastat models. Three illustrations provide supplementary information about contact and terminal arrangements, and four diagrams show mountings and enclosures. Operation of the models is described and coil data and contact specifications are given. **Circle L5 inside back cover.**

TV Transmitter Monitor. General Radio Co., 275 Massachusetts Ave., Cambridge 39, Mass. Volume 31 No. 4 of the *Experimenter* illustrates and describes a new tv transmitter monitor. Illustrations, basic principles, design features and specifications are included. **Circle L6 inside back cover.**

Temperature Indicators. Leeds & Northrup Co., 4934 Stenton Ave., Philadelphia 44, Pa. Data sheet ND46-33 (23) contains concise information about the electronic Speedomax G potentiometer instruments which indicate thermocouple temperatures at the flick of a switch on a drum-type scale 25½ in. long. The sheet lists features, specifications and ranges for (1) a standard-case instrument with door-mounted switches, (2) a small-case instrument used with separately-mounted switches

and (3) a console instrument for desk-top mounting, for as many as 200 thermocouple points. **Circle L7 inside back cover.**

Impulse Counters. Landis & Gyr, Inc., 45 W. 45th St., New York 36, N. Y. A feature of the new Sodeco bulletin describing electric reset impulse counters is a discussion of the shape of impulses recommended to activate the counters.

Also included in the bulletin are illustrations, drawings and descriptions of 4, 5 and 6-digit electric zero reset counters, including descriptions of the various auxiliary contact options available. **Circle L8 inside back cover.**

Facilities Brochure. Laboratory for Electronics, Inc., 75 Pitts St., Boston 14, Mass., has published a 12-page brochure describing its facilities. The company is engaged in the manufacture of electronic test equipment component parts for the electronic industries, in the custom manufacture of complex electronic devices and in electronic research and development. The booklet now available describes and illustrates these facilities. **Circle L9 inside back cover.**

Engineering Guide on Teflon Wire. Alpha Wire Corp., 200 Varick St., New York 14, N. Y., has released the two-color four-page Catalog T-1 describing all the engineering characteristics of its Altemp Teflon high-temperature insulated hook-up wire which uniquely suit it for high-frequency, high-temperature, miniaturizing, weatherizing and ruggedizing applications. Both the extruded and spiral-wrapped insulation types are available in put-ups of 10 ft, 25 ft, 50 ft, 100 ft, 250 ft, 500 ft, and 1,000 ft and are detailed as to conductor sizes, conductor strands, insulation thickness, voltage rating, outside diameter and stock colors. The catalog also includes a series of special constructions of this wire available-to-order. **Circle L10 inside back cover.**

Subminiature Teflon Terminals. Tri-Point Plastics, Inc., 175-177

BIRD Model 43 Thruline DIRECTIONAL WATTMETER

Reads Directly . . . **WATTS FORWARD**

WATTS REFLECTED *. . . In 50 Ohm Coaxial Lines*

Measures POWER into the antenna in the actual operating circuit. Continuous monitoring if desired.

Measures reflected power, direct reading. In antenna matching work, results show directly in lower reflected power.

Ideal for mobile equipment.

Tests 50 ohm r-f lines, antenna connectors, filters—quickly.

ACCURATE because of high directivity and small frequency error.

DIRECT READING – no calibration charts, no full scale meter adjustments needed. Meter scale reads directly for all ranges and is expanded for better down-scale reading.

CONVENIENT – does not require reversal of r-f connections. No auxiliary power required.

Negligible power loss and insertion VSWR.

Full scale power range and frequency range are determined by the selection of plug-in elements from the following list.

Frequency Range—25-1000 megacycles in five ranges vis. 25-60 (A), 50-125 (B), 100-250 (C), 200-500 (D), 400-1000 (E).

Power Range—10, 25, 50, 100, 250, and 500 watts full scale. Available in most frequency ranges.

Accuracy— 5% of full scale.

Model 43 with front element in operating position. Dimensions: 7" x 4" x 3" Weight, 4 pounds.

SO239 jacks for PL259 plugs available.

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TERMALINE Coaxial Line Instruments

VAN GROOS COMPANY
Sherman Oaks, Cal.

Electronic Engineers

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HYCOR TELEMETERING FILTERS

Hycor band-pass and low-pass telemetering filters are produced in exact accordance with accepted military standards. In addition to designs which conform to Applied Physics Laboratory specifications, miniature units are available.

Hycor telemtering filters are potted for complete protection against vibration and humidity. The finest components are used to minimize aging effects on characteristics.

Send for **Bulletin TF** *which describes standard types available.*

Hycor engineers will be pleased to quote on your most exacting specifications.

Representatives in Principal Cities

HYCOR

Division of International Resistance Co.
12970 Bradley Ave., Sylmar 1, Calif.

Willets Road, Albertson, L. I., N. Y. Subminiature, Teflon-insulated terminals that can be installed in seconds and used under severe conditions are described in two technical bulletins. The bulletins provide terminal dimensions, capacitance and flash-over ratings. Four stand-off and five feed-through subminiature Trinseel terminals are described. Sizes range from 0.148 in. to 0.218 in. diameter, all with 0.040-in. diameter brass conductor pins with a variety of solder finishes available. Installation is by simply pressing or corking the terminal into drilled or punched holes, a permanent hold and seal being effected by resilient Teflon insulation.

Copies of Trinseel bulletins MT-157-S (standoff terminals) and MT-757-F (feedthrough terminals) are available. **Circle L11 inside back cover.**

Resistance Measuring Bridges. Shallcross Mfg. Co., Collingdale, Pa. Seven bridges covering d-c resistance measurements from 1 μohm to 1-million megohms to tolerances as close as ± 0.02 percent are described in bulletin L-19B. Types illustrated range from general-purpose Wheatstone bridges for laboratory and field use, and Kelvin-Wheatstone and Megohm-Wheatstone bridges for precise measurements of extremely low or extremely high resistances, to special purpose percent-limit bridges that make resistance measurements within preset tolerance on a fast go, no-go type of production line basis. **Circle L12 inside back cover.**

Lighted Pushbutton Switch. Micro Switch, A Division of Minneapolis-Honeywell Regulator Co., Freeport, Ill. Data sheet 116 covers the 52PB7-T2 turn-to-lock-down lighted pushbutton switch. The dual-purpose switch described functions as a conventional pushbutton when pushed straight down; when pushed and turned 30 deg clockwise, the switch is held maintained in the operated position; when turned counterclockwise from this position, the button pops up and returns the switch to the unoperated position. Included in the catalog sheet are dimensional drawings, electrical rating and prices. **Circle L13 inside back cover.**

Metal Film Precision Resistors. International Resistance Co., 401 N. Broad St., Philadelphia 8, Pa. The four-page catalog data bulletin B-3 contains comprehensive data on construction, applications, characteristics, identification, tolerance and dimensions of a line of metal film precision resistors. Detailed performance charts and graphs are included. **Circle L14 inside back cover.**

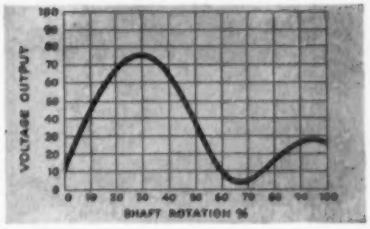
Analytical Instruments. Perkin-Elmer Corp., Norwalk, Conn., has published a 16-page catalog of laboratory analytical instruments. It describes the company's line of infrared and ultraviolet spectrophotometers, monochromators, flame photometers, vapor fractometers, as well as accessories and instrument components available for use with them.

Also included is a brief description of P-E's process control instruments. **Circle L15 inside back cover.**

Instruments Catalog. Humphrey Inc., 2805 Canon St., San Diego 6, Calif., has published a new 24-page catalog with photos, descriptions, general specifications and test data on 21 of its standard precision guidance and control instruments.

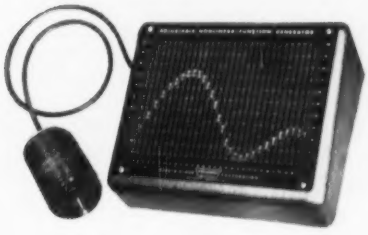
The catalog contains information on free gyros and rate gyros, linear and angular accelerometers, and rectilinear and rotary potentiometers. It includes an outline drawing and connection diagram for each instrument in addition to specifications and description. One section is devoted to a description of the company's test procedures set up to assure quality performance of each individual instrument produced. **Circle L16 inside back cover.**

Bobbin Winder. Geo Stevens Mfg. Co., Inc., Pulaski Rd. at Peterson, Chicago 30, Ill. A newly issued catalog page pictures and fully



How would you **match this curve to shaft rotation?**

The VERNISTAT Adjustable Function Generator will do it for you! Here it is:



The VERNISTAT Adjustable Function Generator—a variation of the VERNISTAT a.c. potentiometer—permits quick and easy alteration of any nonlinear function. The adjusting mechanism provides a graphic display of the function which may be mathematical or empirical, including those with multiple slope reversals.

CHARACTERISTICS:

- 100-transformer taps connected to 31-pole, 100-position printed circuit switch.
- any pole can be switched to any tap.
- size: 6¼" x 7⅞" x 2⅞".
- potential of each pole adjustable to ±0.5%.
- mininum slope of voltage output curve: zero.
- maximum voltage between adjacent poles: 12.
- frequency rating: 400 or 60 cps, @ 130 volts depending on model.
- output impedance: 130 ohms maximum.

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division
PERKIN-ELMER CORPORATION
Norwalk, Connecticut

describes the model 312-AM high-speed, direct-drive, adjustable winding length, bobbin winder in which gear changing is eliminated. Complete technical data include description and dimensions of coils and wire sizes wound, tension equipment selector, winding speeds and range, slow-start, reduced setup time, motor equipment, counter, brake, mounting, time-saving resettable wire guide and carriage, reversing magnetic clutches, output end of spindle, emergency safety stop button, single shot lubrication and tailstock. **Circle L17 inside back cover.**

Instruments Catalog. Brush Electronics Co., 3405 Perkins Ave., Cleveland 14, Ohio, has released a new condensed catalog, illustrating and describing its complete line of Bruel & Kjaer instruments for sound, strain, vibration and acoustical measurements. The 24-page literature contains more than 60 photographs. It is sectioned for ease of reference and includes instruments for production testing, chart paper and accessories.

A brief description accompanies a photograph of each of the instruments covered. The catalog also includes a list of the company representatives, including their territories, where additional information can be obtained. **Circle L18 inside back cover.**

Comprehensive Engineering Service. Briggs Associates, Inc., 10 DeKalb St., Norristown, Pa. A four-page folder covers the company's available engineering service in electronics, mechanisms and materials. Development work; systems, subprojects or product ideas; surveys undertaken and facilities available are discussed. **Circle L19 inside back cover.**

Vinyl Compounds. Bakelite Co., A Division of Union Carbide & Carbon Corp., 30 E. 42nd St., New York 17, N. Y. Issue No. 95 of Kabelitems covers a line of vinyl wire and cable insulating and jacketing compounds. Included are charts showing suggested uses,

Stromberg-Carlson's new type "E" relay combines the time-proven characteristics of the type "A" relay with a mounting arrangement common to many other makes.

As the sketch above shows, our new frame mounting holes and coil terminal spacing allow you to specify these relays—*of "telephone quality"*—interchangeably with brands you have been using. Costs are competitive and expanded production means *prompt delivery*.

Welcome engineering features of the new "E" relay are—

★ **Contact spring assembly:** maximum of 20 Form A, 18 B, 10 C per relay.

★ **Coil:** single or double wound, with taper tab or solder type terminals at back of relay.

★ **Operating voltage:** 200 volts DC maximum.

You may order individual can covers in a choice of 3 sizes for the new relay, as well as for our type "A" and "C" relays.

For complete details and specifications on the "E" relay and other Stromberg-Carlson relays, send for your free copy of Catalog T-5000R.

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Our facilities are geared to meet your production and engineering needs for components of any description. Unusually Complete Tool Room • Press Shop • Hydrogen Annealing, Machining and Polishing Operations • Glass-to-Metal Hermetic Sealing. Production of completed parts ready for assembly in your own plant.

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Over 3,000 high precision tools and dies available to reduce your initial tooling time and costs.

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UL designations and technical data sheets on ten types of Bakelite vinyl compounds. **Circle L20 inside back cover.**

High Reliability Capacitors. Sprague Electric Co., North Adams, Mass. Engineering bulletin 2900 and specification PV-100 contain complete technical information on the Hyrel Q subminiature metal-clad paper capacitors which are hermetically sealed with compression-type glass-to-metal solder-seal terminals. The units described are available in both conventional tubular and screw-neck mounting styles, are vitamin Q impregnated and designed for operation from −55 C to +125 C. Voltage ratings of 200, 300, 400 and 600 v d-c are standard. **Circle L21 inside back cover.**

Magnetizers. The Indiana Steel Products Co., Valparaiso, Ind. A two-page bulletin offers two principal types of magnetizers—the electromagnetic and the permanent-magnet type. The magnetizers discussed meet the requirements of most applications and offer many advantages.

The publication includes data and charts on the magnetizers as well as information and pictures of both types and also includes directions on how to use the magnetizers. **Circle L22 inside back cover.**

Microlimit Control Cable Gage. Industrial Gauges Corp., West Englewood, N. J. A new brochure describes continuous, noncontact diameter measurement and control equipment for insulated wire and cable, extruded tubing and shapes.

The equipment described spans the range of 0.4 to 3.0 in. in two standard sizes and up to 12 in. in special sizes. Measurement, control and recording sections are offered in a variety of combinations to suit specific objectives. **Circle L23 inside back cover.**

D-C Motors. Induction Motors Corp., 570 Main St., Westbury, L. I., N. Y. Engineering data on the special-purpose 2000 series d-c motors are presented in a new de-

sign specification sheet. Units discussed are available in a variety of input voltages, output powers and windings and are offered with gear speed reducer and/or speed governor. Performance curve and engineering drawings of units are included. **Circle L24 inside back cover.**

D-C Supply for Large Currents. Dynamic Controls Co., 1955 Massachusetts Ave., Cambridge, Mass. Bulletin DC T-157 presents the transient performance and other electrical and mechanical features of these well-regulated thyratron supplies. Oscillographic recordings show the response of the output voltage for a 150-v 50-ampere supply upon the application of step functions of a-c line voltage and large increments of load. Features discussed are as follows: Response time is less than 10 millisec and recovery is completed within 20 millisec. Voltage regulation is within ±0.15 percent. Unusual features included are adjustability of output voltage with a single knob from 110 percent of rated to 20 percent of rated, full current rating at all voltages, close regulation throughout the operating region and an efficiency of more than 80 percent at full load. **Circle L25 inside back cover.**

Environmental effects on Precision Pots. Helipot Corp., Newport Beach, Calif., has available free copies of the illustrated technical paper 762 which discusses the effects of extreme temperatures, vibration and shock, humidity, altitude and acceleration on precision potentiometers. Included in the discussion are an analysis of applicable specifications, potentiometer characteristics affected by the various environments and a detailed description of each environmental condition. **Circle L26 inside back cover.**

Testing Equipment. Cal-Tronics Corp., 11307 Hindry Ave., Los Angeles 45, Calif., has published a brochure detailing its specialized electronic testing equipment products. In addition to testing equipment information for guided missiles, radar and fire control, the

Zell
Compression and Kovar Type
HERMETIC SEALS
"The Seal of Excellence"
Meeting the ever-increasing standards of perfection established by the electronics industry is a challenge admirably met by Zell's highly skilled engineers. They are able to exercise unusually rigid quality controls because all production operations are carried out in Zell's own completely equipped, ultra modern plant.
ZELL Hermetic Seals Enjoy These Desirable Characteristics:
★ High resistance to mechanical and thermal shock.
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Specialists IN STAMPING AND DRAWING KOVAR — RODAR — THERLO — FERNICO AND OTHER ALLOYS
ALL FACILITIES UNDER ONE ROOF
• Complete tool room facilities.
• 65 Power Presses (to 50 tons).
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ZELL engineers control every process every step of the way, assuring uniform quality and performance.
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The completeness of our facilities assures the completeness of your satisfaction!

NEW AMCI AUTOMATIC IMPEDANCE PLOTTER
For Lab or Production Testing
Just turn the oscillator dial, manually or by a motorized sweep drive, and the impedance curve of load Z is traced on a regular or an expanded Smith chart. Either an oscilloscope or a two-axis recorder can be used.
Write for descriptive bulletin E 557
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Oscillator
Load "Z" to be measured
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299 ATLANTIC AVE., BOSTON, MASS
Model 11-P ..... 200 mc — 960 mc.
Model 11-Q ..... 30 mc — 400 mc.
INSTRUMENTS — ANTENNA SYSTEMS — COMPONENTS — AIR NAVIGATION AIDS

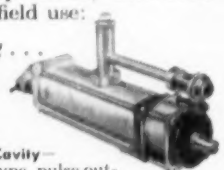
NOW...ANY MICROWAVE COMPONENT CAN BE BUILT AND ENGINEERED TO YOUR PARTICULAR APPLICATION

Regardless of complexity, design or tolerance problems—you can get UHF or microwave components that are job-engineered to your application. All units are delivered, *electrically tested and proven*, ready for immediate operation.

Components can be built from your prints or can be designed and built to integrate with the application. Close and confidential coordination is maintained from drawing board stage to installation.

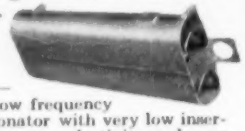
Range of assemblies is practically unlimited—from dc. to over 40,000 mc., military or industrial. Typical examples are these components, delivered ready for field use:

Telemetering . . .



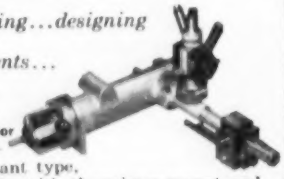
Tuneable S-Band Transmitter Cavity—re-entrant type, pulse output 150 w., operates at extreme altitudes and under extreme conditions of temperature, humidity and salt spray.

Improving signal-to-noise ratio . . . selectivity . . .



Tuneable UHF Pre-Selector—relatively low frequency coaxial resonator with very low insertion loss, extreme selectivity and very high signal-to-noise ratio. Especially adapted to use in aircraft or in crowded communication bands.

Calibrating . . . designing S-Band components . . .



S-Band Signal Generator Cavity—re-entrant type, complete with thermistor mount and calibrated variable attenuator. Frequency range 2700 to 3400 mc.

•

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Get the facts on our complete design, engineering and mechanical fabrication facilities. Have us quote on your needs—cavities, mixers, duplexers, multipliers, rotary joints, twists, bends and other components or assemblies.

Contact us today. Request catalog.

J-V-M J-V-M ENGINEERING COMPANY

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(Chicago Suburb)

brochure contains information on engineering, designing and planning personnel.

Foto-Etch Circuits, a division of Cal-Tronics, is also featured. This division provides complete service in printed circuitry including artwork, engineering and design. **Circle L27 inside back cover.**

Direct-Writing Recording Systems. Brush Electronics Co., 3405 Perkins Ave., Cleveland 14, Ohio, has released a six-page folder illustrating and describing its direct-writing recording systems.

Covered in the profusely illustrated literature is the company's line of oscillographs, amplifiers and its penmotor, plus accessories and supplies used with the basic instrumentation. In total, five oscillograph models and six amplifier models are pictured and more than a dozen are described.

The folder also lists application information, plus application and design features of many of the instruments covered. **Circle L28 inside back cover.**

Silicon Power Rectifiers. Hughes Products, A Division of The Hughes Aircraft Co., International Airport Station, Los Angeles 45, Calif. Data sheet DS40 contains physical and electrical characteristics for a series of 10 new silicon power rectifiers. For information not appearing on the data sheet, sales engineers are available to discuss specific requirements. **Circle L29 inside back cover.**

Infrared-Sensitive Photoconductors. Electronics Corp. of America, One Memorial Drive, Cambridge 42, Mass. Infrared-sensitive lead-sulfide photoconductors for detection and guidance systems are described in a new bulletin.

Technical specifications and ordering information are given for four general cell types having a wide range of performance characteristics. Charts for cell response as a function of both wavelength and source temperature are shown.

The bulletin tells how lead sulfide semiconductive surfaces have advantages over other radiation-

Anywhere . . .
At sea, in the icy cold of the antarctic! S.S.WHITE Molded Resistors in values up to 50,000 megohms retain their characteristics.
in Any Weather
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Our resistors are characterized by low noise level . . . precision . . . stability . . . have negative temperature and voltage coefficients. Compact . . . excellent stability and mechanical strength . . . values do not deteriorate due to age.

We'll be glad to cooperate with you in applying these high-quality resistors to your product. For our Bulletin 5409, just drop a line to Dept. R.

S.S.White

INDUSTRIAL DIVISION

10 East 40th Street
New York 16, New York

sensitive materials in terms of response, sensitivity, response time, and signal-to-noise ratio. Their applications include missile guidance, fire control, aerial mapping, data reduction and spectroscopy. **Circle L30 inside back cover.**

Ultrasonic Equipment. Branson Instruments, Inc., 37 Brown House Road, Stamford, Conn., has available a pamphlet describing a line of ultrasonic equipment for thickness testing, flaw detection and metal cleaning. Instruments covered include the Vidigage and Audigage thickness testers, the Sonoray ultrasonic transmission tester, the Coatingage magnetic thickness gage and the Sonogen ultrasonic power generators. **Circle L31 inside back cover.**

Integrating Gyro. Reeves Instrument Corp., 215 E. 91st St., New York 28, N. Y. Technical data sheet 202 illustrates and describes the 201G integrating gyro. Included are design features, dimensional drawings and typical specifications. **Circle L32 inside back cover.**

Pressure Sensing Devices. Clark Electronic Laboratories, Box 165, Palm Springs, Calif. Bulletin 276 illustrates and describes Celab pressure cells and devices. Included is information on force, vacuum and tension cells; stud mounted pressure contactors; high pressure load cells; microminiature pressure cells; and paints, liquids, plastics and powders for research and design engineers. Purchasing information and prices are given. **Circle L33 inside back cover.**

Aircraft Equipment Mounting. Lord Mfg. Co., Erie, Pa. Bulletin No. 705 illustrates and describes Radiofocal mounting bases for aircraft electronic equipment. Included are a resonance curve and a table of natural frequencies. Availability of the company's engineering staff is also discussed. **Circle L34 inside back cover.**

Electronic Tracking Systems. Cubic Corp., 5575 Kearny Villa Rd.,

Why "CHOKE" your soldering iron?

— just "CRADLE" it with a

HEXACON

HATCHET SOLDERING IRON

The operator has to "choke" the conventional straight iron to hold it, whereas the HEXACON HATCHET IRON "cradles" in the hand with no perceptible grip whatsoever — *thus relieving hand strain* and eliminating the "heavy hand", the cause of poorly soldered joints. Because HEXACON HATCHET IRONS are *perfectly balanced* in weight, they enable the operator to solder in a natural position and relieve fatigue of arm and back.

Send for new circular No. 70H giving more details and comparative competitive performance data.

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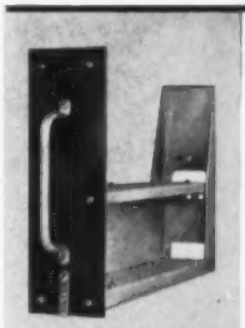
—Originator and Pioneer

CAT. NO.	WATTS	TIP DIA.	PRICE
25H	25	1/8"	$ 6.50
26H	30	3/16"	6.50
30H	60	1/4"	6.75
70H	80	3/8"	11.00
100H	100	3/8"	12.00
150H	150	3/8"	12.75
151H	175	1/2"	13.50
200H	200	5/8"	14.00
300H	300	7/8"	18.25

HEXACON ELECTRIC COMPANY
130 West Clay Ave., Roselle Park, New Jersey

INDUSTRY'S No. 1 HEXACON SOLDERING IRON



Churchill ¼ ATR Cases

Meet ARINC Spec #404

- Saves Space
- Adapted to use of miniature electrical components
- Employs newer type Cannon DPA multiprong connector
- Standard configuration of indexing pin holes (Can be used as guard against equipment being plugged into wrong location in radio or equipment racks)
- Three separate removable deck plates provides large area for mounting electrical components
- Units carried in stock. Indexing pin holes added upon request.

MODIFICATIONS MADE TO MEET SPECIFIC REQUIREMENTS

For further details write for Data Sheets #5 and #6

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IT'S POWRARM RIGHT DOWN THE LINE

. . . At Power Products Co., Grafton, Wis.

Wilton PowRarms, placed every two feet on a 100' long conveyor, help Power Products Corporation assemble six gasoline engine models on a single line. PowRarms, which can be moved to any angle in all three planes, and locked in position, enable operators to adjust work pieces to any convenient angle of approach. The result is an exceptionally high rate of production on all models. **PowRarms** come in a wide range of automatic and manual models.

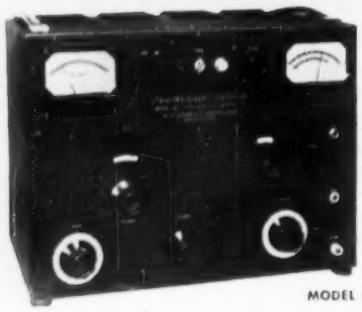
Attach this ad to your letterhead for a free demonstration or literature!

WILTON TOOL MFG. CO., INC.

SCHILLER PARK, ILLINOIS

Sold by Leading Distributors The World Over

This ONE instrument checks RF, IF, and AF performance of receivers.



MODEL 82

Standard Signal Generator

20 cycles - 50 mc.

SPECIFICATIONS:

FREQUENCY RANGE: 20 cycles to 200 Kc. in four ranges. 80 Kc. to 50 Mc. in seven ranges.

OUTPUT VOLTAGE: 0 to 50 volts across 7500 ohms from 20 cycles to 200 Kc. 0.1 microvolt to 1 volt across 50 ohms over most of range from 80 Kc. to 50 Mc.

MODULATION: Continuously variable 0 to 50% from 20 cycles to 20 Kc.

POWER SUPPLY: 117 volts, 50/60 cycles. 75 watts.

DIMENSIONS: 15" x 19" x 12". Weight, 50 lbs.

FEATURES:

- Continuous frequency coverage from 20 cycles to 50 mc.
- Direct-reading individually calibrated dials.
- Low harmonic content.
- Accurate, metered output.
- Mutual inductance type attenuator for high frequency oscillator.
- Stray field and leakage negligible.
- Completely self-contained.

Laboratory Standards **MEASUREMENTS CORPORATION**

BOONTON · NEW JERSEY

San Diego 11, Calif. Document B-571 is a 16-page brochure describing the company's tracking systems designed and produced for the U.S. Air Force. Angle-measuring equipment (AME) and distance-measuring equipment (DME) are discussed and their applications are given. **Circle L35 inside back cover.**

Component Machining and Testing. Paraplegics Mfg. Co., Inc., 10068 Franklin Ave., Franklin Park, Ill., has prepared a new eight-page booklet giving full description of its facilities for machining and testing of electrical and electronic components. **Circle L36 inside back cover.**

Copper-Clad Laminate. Formica Corp., 4411 Spring Grove Ave., Cincinnati 32, Ohio. "New Formica Cirprint" is the title of a four-page, two-color brochure describing the characteristics of Cirprint, the new copper-clad laminate specifically developed for the printed circuits used in the radio and tv industries.

Cirprint meets military specification MIL-P-3115B for type PBE-P. Copies of brochure No. 755 are available. **Circle L37 inside back cover.**

Radar Reflectors. Millcraft Inc., 1119-21 Merriam Blvd., Kansas City 3, Kansas. A four-page folder illustrates and describes a line of radar reflectors which have had thorough testing and are currently in use by several agencies of the Department of Defense. Included are the 360 Multi-Unit series for airborne radars, the 10 series of calibration reflectors for ground radar and the 200 series for maritime applications. **Circle L38 inside back cover.**

Aluminum Plugs and Sockets. The Plessey Co., Ltd., Kembrey St., Swindon, Wilts., England, has published a brochure listing the entire range of soldered and solderless Mk. 4 aluminum plugs and sockets and indicating correct outlet fittings for every size and type of cable in normal use. The connectors listed have a wide field of application, particularly in

communications equipment and aircraft. Complete cross referencing is included.

The brochure is available to design engineers. **Circle L39 inside back cover.**

Measurement. The Sheffield Corp., Dayton 1, Ohio. A pictorial story of measurement covering 66 centuries is given in "Manufacture and Measurement for Mankind," a four-page brochure. The electronic amplifier is among the modern measurement methods discussed and illustrated. **Circle L40 inside back cover.**

Batteries for Transistor Applications. Ray-O-Vac Co., 212 E. Washington Ave., Madison 10, Wisc., has issued a new engineering handbook section on the subject of batteries for transistor and electronic applications. Individual specification sheets on the physical dimensions of the batteries and charts showing discharge characteristics and potentials are included. The introduction to the specification sheets points out that the metal clad, sealed-in-steel construction used on several of the unit cell batteries is especially advantageous where problems of leakage or a long shelf life requirement might arise. **Circle L41 inside back cover.**

Parabolic Antennas. Prodelin Inc., 307 Bergen Ave., Kearny, N. J. Bulletin No. 436 covers parabolic antennas for line-of-sight and tropospheric scatter services. Specifications, features and ordering information are included. **Circle L42 inside back cover.**

Flexible Couplings. Naugler Engineering Inc., 19 Madison Ave., Beverly, Mass., has available a new four-page bulletin on flexible couplings which are designed to provide maximum flexibility combined with high torque capacity and zero backlash. The bulletin gives complete details on the ¼ in., ⅜ in., 1 in. and 1½ in. diameter models with dimensions and graphs for lateral and torsional deflection. The couplings discussed feature dynamic balance and low inertia and require no

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new . . . PRECISION "POT" by GENERAL CONTROLS

PRM 123

PRM 123
Rotary type, single gang, 1-5/16" dia., bushing mounted, sleeve bearing.

General Controls, famous for 25 years as a supplier of mechanical and electro-mechanical controls for home, industry and the military . . . proudly announces a new product of its Potentiometer Division . . .

FEATURES . . .

- Variations from 100 to 50,000 ohms resistance.
- Standard tolerances ±3% resistance, ±0.3% independent linearity.
- Exceeds MIL-R-12934,-E-5272A Specs.
- Explosion-proof, or dust-tight seals.
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- Special Spec. Models Available.

Write for 1956 Catalog!

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Factory branch offices serving all principal cities of the United States and Canada

Little Mag says: TWO GREAT NAMES!

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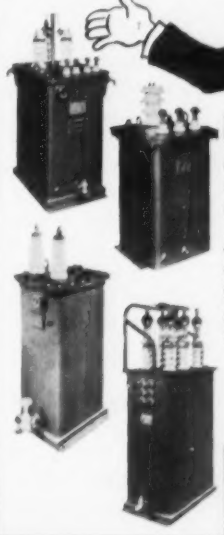
RADIO ENGINEERING LABORATORIES, INC. (Top Name in Tropo Scatter).

MAGNATRAN

MAGNATRAN, INCORPORATED (Top Name in Magnetic Components for Tropo Scatter Power Supplies).



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More Kilowatt miles of Tropo equipment by (REL) are in use and in production than those of all other companies combined . . .

More Kilowatt miles of (Magnatran) Components and equipment are in use and in production than those of all other companies combined.

MAGNATRAN has provided the following equipment for these major projects:

THE FIRST: POLEVAULT
THE LARGEST: WHITE ALICE
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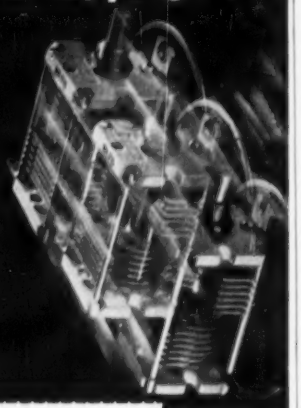
VIBRATION and SHOCK!



Ceramic-soldered for greater strength!

Parts can't break loose... capacity can't fluctuate!

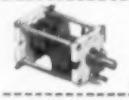
These ceramic-soldered Johnson Type "L" capacitors are an ideal choice for applications requiring extreme stability and strength. Rotor bearings and stator support rods are actually soldered directly to the heavy 3/16" thick steatite ceramic end frames. Impervious to shock and vibration, parts can't break loose . . . capacity can't fluctuate.

SPECIFICATIONS

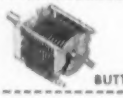
Plate spacing is .030" rated at 1500 volts peak at sea level; over 300 volts at 50,000 feet altitude. Plating is heavy nickel . . . other platings available on special order. Requires 1⅜"x1⅜" panel mounting area.

● For complete information on Johnson Type "L" Air Variables or other quality Johnson components—write for your free copy of our newest catalog today!

SINGLE



DUAL



BUTTERFLY

DIFFERENTIAL

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lubrication. **Circle L43 inside back cover.**

Glass Products. Corning Glass Works, Corning, N. Y. A product directory folder gives a broad view of the 35,000 products made yearly by the company. Many electronic and allied products are listed. **Circle L44 inside back cover.**

Magnetizers. The Indiana Steel Products Co., Valparaiso, Ind., has released a two page bulletin on magnetizers. The company offers two principal types of magnetizers —the electromagnetic and the permanent-magnet types.

The publication includes data and charts on the magnetizers as well as information and pictures of both types and also includes directions on how to use the units. **Circle L45 inside back cover.**

Teflon Rod. Tri-Point Plastics, Inc., 175-177 I. U. Willets Road, Albertson, L. I., N. Y. Bulletin T-257-R contains information on properties, specifications and price reductions of TSI Teflon rod. It covers the 40 diameters now available, ranging from 0.125 in. to 1.000 in., in increments of from 0.003 in. in popular diameters, to 0.014 in. and 0.032 in. in others. Supplied in lengths of 10 and 12 ft, rod diameters discussed are within ±0.002 in. of those indicated. **Circle L46 inside back cover.**

Motors, Fans and Blowers. Ashland Electric Products, Inc., 32-02 Queens Blvd., Long Island City 1, N. Y. Catalog No. 83 is a 16-page booklet showing illustrations, physical specifications and electrical characteristics of a line of specialty motors, fans and blowers. All units discussed are manufactured to order and can be delivered in a few weeks. **Circle L47 inside back cover.**

Electrodynamic Recorders. Massa Laboratories, Inc., Hingham, Mass. A single-sheet bulletin covers two electrodynamic recorders—models GA-1023 and M-133.

Features of the units described

Using Thermistors

Edited by
FENWAL ELECTRONICS

Thermistors, with their almost incredible sensitivity to temperature change, now get a news column all their own.

The cases in point for the first column: temperature measurement and temperature control.

Three basic circuits for temperature measurement with thermistors:

FIG. 1

FIG. 2

FIG. 3

The first is a battery, a thermistor, and a micro-ammeter. The second, more sensitive, has a thermistor as one leg of a bridge circuit. The third incorporates two thermistors in a bridge, making possible even more precise temperature differential measurements.

Two basic circuits for temperature control with thermistors:

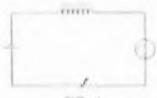

FIG. 4

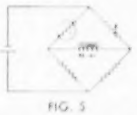

FIG. 5

The first has a thermistor in series with a relay, a battery, and a variable resistor. By adjusting the resistor, it is possible to make the relay operate at any desired temperature of the thermistor.

The second is more sensitive, and has a thermistor as one leg of a bridge circuit, a variable resistor in another leg, and a polarized relay across the output. Even more sensitive control can be had by applying AC to the bridge and placing a high-gain amplifier between the bridge and the relay.

Designers: if you are not already familiar with the tremendous possibilities of thermistors, write for details to FENWAL ELECTRONICS, INC., 24 Mellen St., Framingham, Massachusetts.

Fenwal Electronics

Makers of Precision Thermistors

are true rectilinear motion, critical acoustic damping and wider frequency range. Performance characteristics and prices are included. **Circle L48 inside back cover.**

Computing Digital Indicator. Dynac, Inc., A Subsidiary of Hewlett-Packard Co., 395 Page Mill Road, Palo Alto, Calif. A single-sheet loose-leaf perforated bulletin covers model DY-2500 computing digital indicator. Features, illustrations, uses, specifications and prices are included. **Circle L49 inside back cover.**

Epoxy Shells. Epoxy Products, Inc., 137 Coit St., Irvington, N. J., has available complete catalog information on their new molded epoxy N-Case shells. The shells described are ideal for the encapsulation of resistors, coils, capacitors and other electronic components.

The N-Case shells discussed make it possible to insert the component directly into the shell, pour epoxy casting compound in after it and end up with a completely encapsulated component, resistant to humidity, temperature variations and corrosive influences. **Circle L50 inside back cover.**

Analag Computer. Donner Scientific Co., 888 Galindo St., Concord, Calif., announces its new four-page engineering data sheet for the model 3000 analog computer.

The computer's building-block design, problem-handling capacity and accessories are discussed in a comprehensive, but easy-to-read manner. Complete prices, typical module combinations and recommended computing facilities are also included. **Circle L51 inside back cover.**

Floated Rate Gyros. Norden-Ketay Corp., Commerce Road, Stamford, Conn. A four-page folder illustrates and describes new floated rate gyros which feature novel temperature control volumetric thermostat, signal pickoff, ruggedness, reliability and precision. The gyros discussed in bulletin No. 419 have been designed to

TRACER-GUIDED DRILLING
100 HOLES P. M.
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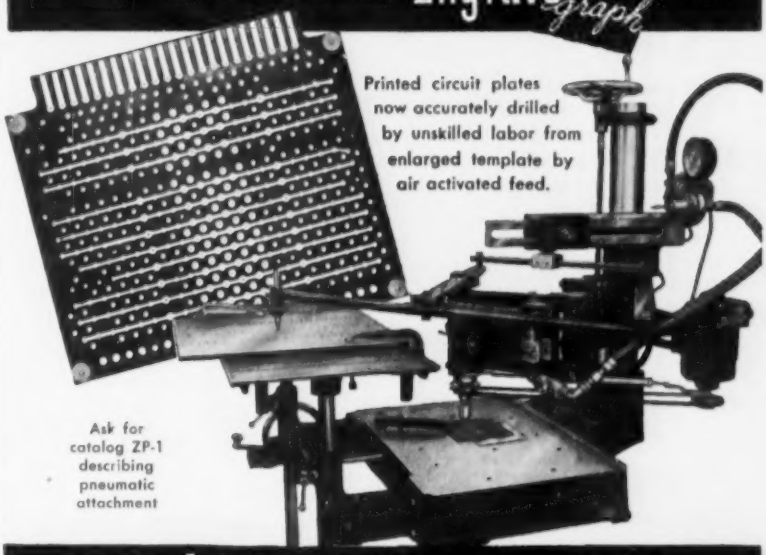
Printed circuit plates now accurately drilled by unskilled labor from enlarged template by air activated feed.
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ENGINEERS: THE WONDERFUL COMMERCIAL JET ERA IS OPENING UP AT TWA

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Qualifications: B.S. in Engineering.

Location: TWA's ultra modern building now nearing completion at Kansas City, Mo.

Living Conditions: Excellent, both city or suburban private homes or apartments.

Benefits: Many employee benefits, including liberal free transportation for yourself and family each year.

Salary: Commensurate with experience.

If you are an engineer with qualifications in any of these fields, explore your opportunity with TWA today. Write:

Mr. R. Paul Day, Employment Manager
TRANS WORLD AIRLINES
Kansas City 5, Missouri

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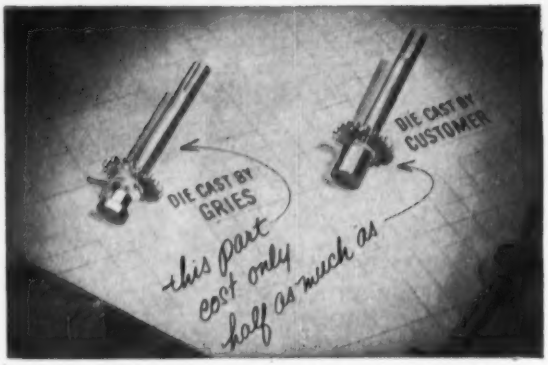
with GRC die cast tiny parts!

Range timer part made by Gries costs *half* as much as part die cast by the customer



Quick deliveries on quantities of 100,000 to many millions.

NO MINIMUM SIZE!

Maximum weight: ½ oz.
Maximum length: 1¾"

Send today for bulletin.

Many manufacturers have learned that GRC specialized techniques and facilities have cut the cost of tiny components for their products 50% and more compared with production in their own plants. Parts like the slotted gear shaft illustrated are die cast to precise specifications—trimmed, ready for use—in one *automatic* operation. Consult Gries about cost-cutting components for your products.

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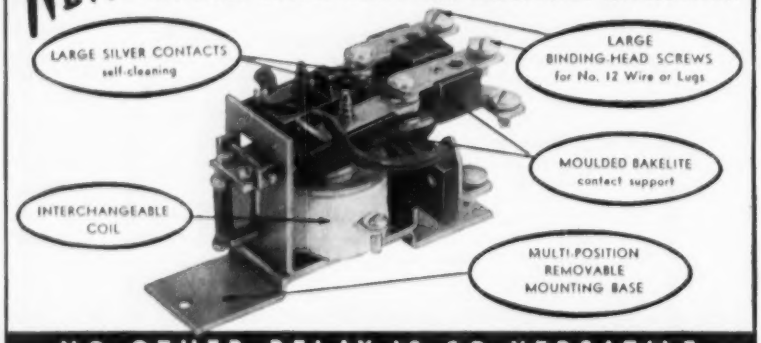
NEW GENERAL PURPOSE RELAY

(SERIES 130 RELAY)

THE MOST USEFUL RELAY FOR INDUSTRIAL APPLICATION


LARGE SILVER CONTACTS self-cleaning
LARGE BINDING-HEAD SCREWS for No. 12 Wire or Lugs
MOULDED BAKELITE contact support
INTERCHANGEABLE COIL
MULTI-POSITION REMOVABLE MOUNTING BASE

NO OTHER RELAY IS SO VERSATILE

SPECIFICATIONS

CONTACTS	RATINGS	COILS	MOUNTING BASE
Single-and-double pole	20 amp. at 115 V	AC & DC to 230 V	Metal strap or bakelite. Base can be rotated 90 degrees either direction for mounting convenience.
Single-and-double throw	60 Cy. AC or 24 V DC	(Interchangeable)	
Aux. DT contacts available	U.L. Approved	Power—2 watts	

DIMENSIONS Base—1" x 3⅛"

Request complete data on Series 130 Relay.

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RELAYS W S LONG BRANCH, N. J.

meet the performance requirements of modern missile programs. **Circle L52 inside back cover.**

Products Catalog. Anderson Controls, Inc., 2777 Mannheim Road, Des Plaines, Ill., announces availability of its new complete multicolored product catalog. The publication gives in complete detail, pictures and diagrams with pertinent information on solenoids, coils and electrical components. **Circle L53 inside back cover.**

WWV and WWVH. Shasta Division, Beckman Instruments, Inc., P.O. Box 296, Station A, Richmond, Calif. An eight-page two-color brochure describes the function, applications and recent improvements of National Bureau of Standards radio station WWV and WWVH. The brochure (Data File No. 10) also describes the new model 905 WWV receiver. **Circle L54 inside back cover.**

Electrical Connectors. The Pyle-National Co., 1334 North Kostner Ave., Chicago 51, Ill. The four-page bulletin No. 637 announces a new line of compact, lightweight electrical connectors for military and industrial applications.

Known as the Pyle-Star-Line, the new plugs and receptacles described are impervious to water, moisture, oil, gas, dust, pressure, vibration and shock. These connectors meet and exceed performance requirements of class A, B, C and E of military specifications MIL-C5015B.

The bulletin illustrates and describes the new line, with environmental data and electrical capacities. **Circle L55 inside back cover.**

Coil Winding Machine. Geo. Stevens Mfg. Co., Inc., Pulaski Road at Peterson, Chicago 30, Ill., has released a 62-page catalog, No. 57, illustrating and completely describing 48 coil winding machines of which 18 are newly developed models. The various machines wind virtually all types of coils including bobbin, repeater, resistor, solenoid, transformer, variable pitch, armature, field, to-

roidal, space wound, lattice-wound universal, continuous resistance and deflection yoke coils. In addition, a newly developed wire scraper, wire insulating equipment, a new tension safety attachment, four counters and six pages of various accessories and optional equipment are pictured and full technical details given. Also included is a page of time-saving, helpful winding formulas. **Circle L56 inside back cover.**

Transformers. Triad Transformer Corp., 4055 Redwood Ave., Venice, Calif. General catalog TR-57 describes and illustrates over 700 transformers of which 117 are new items. New items include toroids, pulse, transistor, hermetically sealed, geophysical, power, filament and audio transformers, chokes and tv components. **Circle L57 inside back cover.**

Wide-Band Oscilloscope. Laboratory for Electronics, Inc., 75 Pitts St., Boston 14, Mass. Bulletin 411A illustrates and describes the 411A wide-band oscilloscope which features d-c to 10-mc bandwidth; 20 mv per cm sensitivity; 0.035-μsec rise time and direct-reading delay, calibrated in microseconds. Complete specifications are included. **Circle L58 inside back cover.**

Electrodynamic Recorder. Massa Laboratories, Inc., Hingham, Mass. A four-page reprint from ELECTRONICS describes the Massa electrodynamic recorder, a direct inking, nonresonant recording milliammeter incorporating numerous exclusive basic design features. Title of the article reprinted is "Pen Motor for Rectilinear Recording." **Circle L59 inside back cover.**

Thyratron D-C Power Supplies. Dynamic Controls Co., 1955 Massachusetts Ave., Cambridge 40, Mass. Bulletin DC T-157 covers the 150V-25A highly regulated, fast response thyratron d-c power supplies. Performance, electrical and mechanical features are listed. **Circle L60 inside back cover.**

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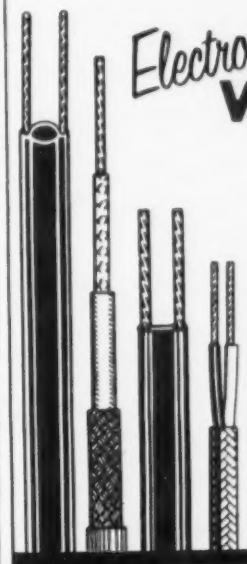

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Plants and People

Edited by WILLIAM G. ARNOLD

Industry technical associations and societies honor outstanding engineers and executives. Manufacturers in electronics enlarge plant expansion plans with new construction, acquisitions or lease arrangements. Engineers move to new positions and duties

RETMA Medal of Honor Goes To Max Balcom

MAX F. BALCOM, former chairman of the board of directors of Sylvania Electric Products and now a director and consultant, was chosen recipient of the 1957 RETMA "Medal of Honor" by the RETMA board of directors. He will receive the award at the RETMA industry banquet in Chicago during the annual convention.

The award, established in 1952, provides industry recognition of the person, company or organization which has made outstanding contributions to the advancement of the industry—the industry's highest award.

The nomination of Balcom was made by Paul V. Galvin, recipient of the 1956 "Medal of Honor" in his capacity as chairman of the annual awards committee.

Balcom was president of RETMA in 1947-48, and in 1954-55 served as chairman of the board. He has been a director of RETMA since 1942. He served as chairman of the tube division for eight years and headed a number of important committees such as television, educational tv, and surplus disposal.

His knowledge of the radio tube and allied electronics fields – including production, sales, finance, and legal problems—has been developed over more than three decades with Sylvania.

Balcom was elected treasurer of Sylvania in 1944, and in 1950, following the death of Walter E. Poor, was elected chairman of the board. He relinquished the treasurership in 1951 to devote his full time to the chairmanship assignments. In 1953, after completing 35 years of service, he retired as board chairman and is now serving as a director and consultant.

Packard-Bell Shows Simple Set, Forms Computer Affiliate

DR. ROBERT S. BELL, president of Packard-Bell Electronics, and Richard B. Leng, vice-president in charge of the firm's technical products division, presented a common component radio receiver, containing but one type of tube, to Major General Preston W. Corderman, Deputy Chief Signal Officer of the Army.

The new receiver is designed to reduce spare parts requirements from nineteen to seven. Only one tube is required where formerly five different types of tubes in various sizes were used, resistor spares are reduced from nine to three, and capacitor spares from five to three.

Commenting on the receiver and its importance General Corderman pointed out that "common, standardized components can greatly simplify the spare parts supply problem in the Military services and wherever possible it is desirable that one type of component perform the same function as several. This new receiver appears to be a step in the right direction".

Major General Preston W. Corderman, right, Packard-Bell president Dr. Robert S. Bell, left, and Richard B. Leng, center.

According to Dr. Bell, the "common component" receiver, in addition to reducing the spare parts inventory, simplifies servicing and maintenance in the field since non-technical personnel can be used in many instances to reduce technical staff.

► **Firm** — Packard Bell Computer Corp. has been formed as an affili-

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Inquiries are invited from Electronics Engineers and Physicists possessing experience or keen interest in technical management. Address E. W. Des Lauriers, Technical Management.

California Division LOCKHEED

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Packard-Bell Electronics Corp.

The new facility has launched a research and development program in the digital computer field.

Max Palevsky, formerly with Bendix Aviation, computer division, will serve as vice-president and director of the subsidiary.

Palevsky has designed several digital differential analyzers, as well as general purpose computers for missile impact prediction.

Radio Club Elects Officers And Directors For 1957

THE Radio Club of America re-elected Frank A. Gunther president of the organization for 1957. Serving with him are Walter A. Knoop, Jr., vice-president; O. James Morelock, corresponding secretary; Joseph J. Stantley, treasurer; and John H. Bose, recording secretary.

Directors for the coming year include: Ernest V. Amy, Ralph R. Batcher, George E. Burghard, Harry W. Houck, Fred A. Klingenschmitt, Renville H. McMann, Jr., Jerry B. Minter, Harry Sadenwater, Francis H. Shepard, Jr., and Albert F. Toth.

Frank A. Gunther

The Radio Club of America was organized in New York City on January 2, 1909, making it the oldest group of its kind in this country. Membership includes outstanding men in the field of radio engineering and invention both in this country and abroad.

Frank A. Gunther is vice-president of sales and production of Radio Engineering Laboratories, Inc., in Long Island City.

Walter A. Knoop is a professional engineer in the firm of Gawler-Knoop Co. O. James Morelock is a radio consultant in Millington, N. J. Joseph J. Stantley is with Continental Sales Co., Inc., of Newark, N. J. John H. Bose is engaged in research at the Electronics Research Laboratories of Columbia University.

Raytheon Establishes New Laboratory In California

RAYTHEON MANUFACTURING Co. is building a 42,000 sq ft electronics laboratory at Santa Barbara, Calif. The Pacific Mutual Life Insurance Company of Los Angeles will own and finance the property, leasing it to Raytheon long-term.

Estimated completion date of the laboratory is mid-June, with occupancy tentatively scheduled for the following month.

The new structure will house about 200 employees of the firm's government equipment division, who will specialize in the design and development of communications, countermeasures, infrared and radar equipments. About half this group is currently working in temporary quarters located in the city of Santa Barbara.

The new laboratory will be a completely integrated unit with its own supporting shops and other services. It will be able to provide complete prototype models of its new electronic devices.

The laboratory will be built on a 15-acre site adjacent to the Santa Barbara airport.

Lockheed Integrates Missile Branches On The West Coast

ENGINEERING and research branches of Lockheed's Missile Systems division will be integrated to facilitate work on several large government programs recently awarded the division.

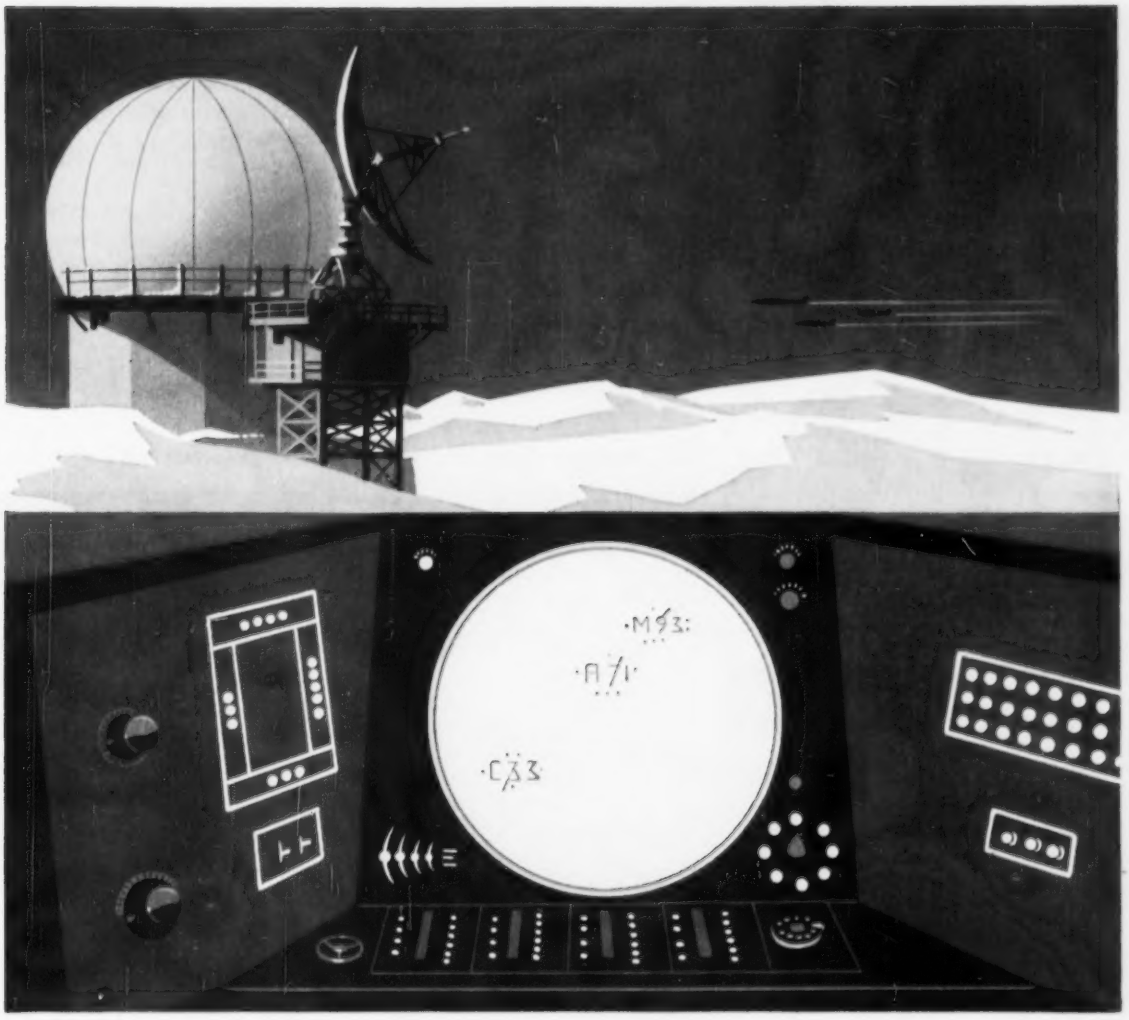
One of these projects is the Navy Polaris, an intermediate-range ballistic missile for which Lockheed is prime contractor.

Head of the new research and development branch will be Dr. Louis N. Ridenour, now director of research.

Willis M. Hawkins, present director of engineering, will be an assistant general manager of the division for one year on a training

Louis N. Ridenour

Willis M. Hawkins



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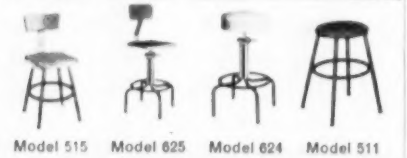

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basis. Then Ridenour will take over the assistant general manager's post for a similar training period, and Hawkins will head the research and development branch.

A newly-created product planning branch of the division will be headed by Wilbur D. Snow, previously in charge of management planning for the Lockheed Corp. This branch will be responsible for long-range planning activities, including facilities, manpower and capital investment.

Among other missile projects under way at Lockheed in addition to Polaris are the Air Force's X-17, a giant test ballistic missile; and the X-7, a cruise missile for testing ramjet engines and other missile components.

Lockheed's missile systems division, which started operations at Van Nuys, Calif. in 1954, last year established two large facilities in the San Francisco Bay Area—a missile plant at Sunnyvale and research laboratories at Palo Alto.

Beverage to Receive Lamme Medal

HAROLD H. BEVERAGE, vice-president of RCA and director of the RCA Laboratories, has been awarded the 1956 Lamme Gold Medal by the AIEE. Presentation of the Medal will be at the Summer General Meeting of the Institute in Montreal June 24.

Dr. Beverage, 29th recipient of the Medal, was awarded it "for his pioneering and outstanding engineering achievements in the conception and application of principles basic to progress in national and world-wide radio communications".

He holds more than 40 patents in the field of radio communications and is co-inventor of the wave antenna and the diversity system for high frequency reception. He has been awarded the Medal of Honor from the IRE, the Morris Liebmann Memorial Prize from IRE and the Armstrong Medal from the Radio Club of America.

His first employment was with General Electric Company in the radio laboratory of Dr. E. F. W. Alexanderson. When Dr. Alexanderson was named first chief engineer of the newly formed Radio Corporation of America in 1920, Dr. Beverage was transferred to that organization to head a laboratory investigating radio propagation and development of transoceanic radio receiving systems. He was appointed chief research engineer of RCA in 1930 and became vice president in charge of research and development in 1940. He joined RCA Laboratories in 1942.

Harold H. Beverage

General Precision Elects Link

E. A. LINK, founder and chairman of Link Aviation, Inc., has been elected to the newly-created post of vice-chairman of the board and also to the executive committee of General Precision Equipment Corp.

Link's new position is an indication that GPE, which has been active in these fields, will expand activities, through its subsidiaries, particularly Link Aviation, General Precision Laboratory, Kearfott Company, and Librascope, in the design and production of various kinds of equipment such as automatic self-contained and accurate systems of aerial navigation.

Link, originator of aerial trainers and simulators, received the U. S. Air Force's highest civilian award, the Exceptional Service Award in 1954. His other honors

E. A. Link

include: the Potts Medal from the Franklin Institute of Philadelphia in 1945; the Wakefield Gold Medal from the Aeronautical Society of London; and honorary degree of Doctor of Commercial Sciences from Tufts College in 1952.

He is a representative of the joint panel of test and training equipment of the guided missiles committee research and development board and a member of the USAF Air Training Command Advisory Board. In 1953-54 he was president of the Institute of Navigation.

RCA Appoints Semiconductor Head

E. V. SPACE has been named to the newly created position of manager, equipment and production development, RCA semiconductor division.

He joined the RCA tube division in 1943, as a development engineer. After 30 months in the armed forces he returned to receiving tube development in 1946. Following seven years in that position he was made manager of production engineering in the transistor department.

In 1956, he was appointed manufacturing manager of the newly formed RCA semiconductor division and continued in that post until his current appointment.

Datascan Opens New Plant

DATASCAN, INC., manufacturers of components and equipment for the industrial control and data handling field, opened a manufacturing

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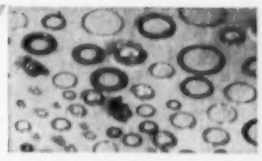

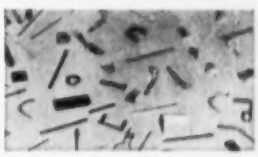

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operation in Little Falls, N. J.

The corporation manufactures a line of delayed signal memory devices. It designs, develops, and constructs data monitoring and processing systems, industrial control systems, and automatic high speed testing-sorting systems.

Morton S. Levin has been appointed director of engineering of the firm. Formerly, he was associated for five years with Tung-Sol where he served as head of the electrical equipment research and design department. Prior to this association, he was employed by the industry service labs of RCA.

M. S. Levin

Federal Selects Semiconductor Chief

MAX ENDERLIN has been appointed chief engineer of the semi-conductor division of IT&T's Federal Telephone and Radio Co. The appointment was announced by Frank M. Viles, Jr., vice-president in charge of manufacture of semiconductors.

Enderlin, who had been aircraft program director for Federal, joined the company in 1943 as senior engineer of rectifier stack design and application engineering. In 1947 he became chief equipment engineer and in 1953 he was promoted to the position of chief engineer of the rectifier equipment department.

Motorola Produces Power Transistors

Paul V. Galvin, left, and Daniel E. Noble of Motorola

THE one-millionth power transistor produced by Motorola's semi-conductor division was presented to Paul V. Galvin (left) founder and chairman of the electronics company by Daniel E. Noble (right), executive vice-president of the C&IE division. Last year Motorola converted the major share of its car radio output to transistor use. The company will add diffused base, radio frequency and silicon

rectifiers to its line in 1957. Power transistors are now being sold to other users.

Edo Expands In Canada

EDO (CANADA) LTD., a wholly owned subsidiary, was formed by Edo Corp. of College Point, L. I., New York, manufacturers of electronic equipment and aircraft components.

The company has purchased 10 acres of property two miles east of Cornwall, Ontario, and plans to erect a medium-size production facility, capable of eventual expansion to 400,000 sq ft. Plans call for the completion of the new plant by September, 1957.

Otis Selects Chief Engineer

OTTO KRAUER was appointed chief engineer of the electronics division of the Otis Elevator Co. He succeeds Phillip L. Finn who has been assigned to the staff of the division manager for special assignments.

He joined Otis in 1928 as a specifier. Since 1929 he has served in various capacities in the engineering department in both the Yonkers works and the executive offices in New York.

Braun Joins California Firm

V. J. BRAUN joined the system development division of the RAND Corp. in Santa Monica, Calif. He has been actively engaged in the fields of electrical engineering and electronics since 1935. He has held positions with RCA, Lockheed, Western Electric, and most recently with the guided missile laboratories of Hughes Aircraft.

Philbrick Appoints Technical Director

BRUCE SEDDON was appointed technical director of George A. Philbrick Researches.

His background includes: circuit

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Inquiries are invited from those possessing infrared experience and strong interest in technical management. Address E. W. Des Lauriers, Technical Management.

California Division LOCKHEED AIRCRAFT CORPORATION

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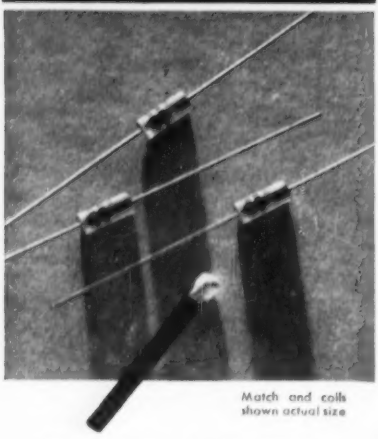
Molded Choke Coils



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Here is a Standardized Series of Molded RF Choke Coils that make other coils look like giants—take up less than half of the space of the next smallest molded coil. Yet these midgets do a big job! Current ratings range to 1800 milliamperes; inductance ranges from 0.15 to 22.0 microhenries. 23 distinct coils (All RETMA standard values). *All* electrical perimeters are exactly defined.

These coils are more than merely satisfactory—they meet or excel exacting specifications, including MIL-C-15305A. Each is tested to crystal accuracy. All are encapsulated in Alkyd providing maximum environmental protection. Standardized production brings you substantial savings and "off-the-shelf" shipments.

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application and systems design in the magnetic amplifier field, development of the first high performance all-magnetic amplifier computing control system for jet engine integrated power control; investigation of internal mechanisms of semi-conductors and the reduction of the solid state theory to engineering practice.

Martin Missile Plant to Expand

THREE new structures, costing a total of $2 million, will be added this year to the just completed Glenn L. Martin missile plant southwest of Denver.

The three structures will add 160,000 sq ft to the present facilities, which cost in excess of $10 million.

The new construction includes a new engineering laboratory, an extension to the administration-engineering building and an addition to the plant cafeteria.

The company has been working since the first of the year on a $358 million government contract for the design, fabrication and testing of an intercontinental ballistic missile called the Titan. There are 2,500 persons at work. The number will be doubled by 1958.

Magnetic Research Adds Another Plant

MAGNETIC RESEARCH CORP. opened its second facility, the engineering and special products division, in Hawthorne, Calif. The 20,000 sq. ft. plant represents a four-fold increase in area for the company.

MRC is retaining its original building in El Segundo, Calif. which now serves as engineering and production facility for the firm's commercial products division.

Activity of the new plant is to produce and expand the line of all-magnetic components, power supplies, amplifiers, systems and other related products.

The enlarged engineering department, housed in the newly opened plant, covers 10,000 sq. ft. Remaining space is devoted to increased production facilities. The move, including plant remodeling and new equipment, involved an expenditure in excess of $300,000.

Fairchild Selects Engineering Manager

CHARLES A. NUEBLING was appointed manager of engineering of the electronics division of Fairchild Controls Corp., subsidiary of Fairchild Camera and Instrument Corp.

The former director of electronics at the Arma division of American Bosch Arma, ran his own business, Nuebling Engineering Associates, from 1953 to 1955. Prior to this he was director of electronics at W. L. Maxson for five years. He has also been with Sperry Gyroscope Company and has served as a technical editor for McGraw-Hill.

Charles A. Nuebling

Sperry-Phoenix Starts Building

SPERRY-PHOENIX CO., a division of Sperry-Rand, has signed agreements for a $1 million plant at Phoenix, Ariz., first phase of an industrial development on a 480-acre site northeast of the Arizona capital.

The building will contain 81,000 sq ft of floor space.

The contract calls for completion

of the building by June 10.

Sperry has moved its electrical computer division to Phoenix. More than $1.5 million in machinery will be installed in the $1 million plant.

Varian Associates Appoint Two

AT VARIAN ASSOCIATES Robert Moog, formerly supervisor of production control, tube division, transferred to the instrument division as manager of instrument manufacturing.

He joined Varian in 1956, after two years in charge of all manufacturing operations at Berkeley division of Beckman Instruments. Previously he was production manager for Bendix radio division and before that, industrial engineer for the Glenn L. Martin Company.

Robert Belville was promoted from staff assistant to supervisor, production control for Varian's tube division. In this capacity he is responsible for all production control activities at San Carlos and for production control activities for the engineering job shop at Palo Alto.

Before joining Varian Associates in December 1955, he was manager of special products for Enterprise Engine and Machinery Co.

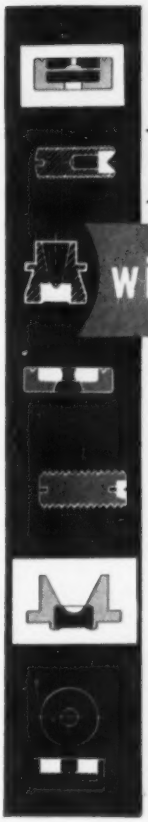
General Radio Expands Plant

GENERAL RADIO CO. of Cambridge, Mass., electronic test equipment manufacturer, is building an 80,000 sq ft addition to its Concord, Mass. branch manufacturing plant.

When complete, the Concord branch will employ about 400. There will be an equal number at the Cambridge headquarters.

Synthetic Mica Elects V-P

W. D. KLEPPINGER has been elected a vice-president of Synthetic Mica Corp., a subsidiary of Mycalex Corp. of America. Kleppinger, who has been assistant to the president of Mycalex since March, 1956, will assume complete charge of all operations at the Caldwell Township,



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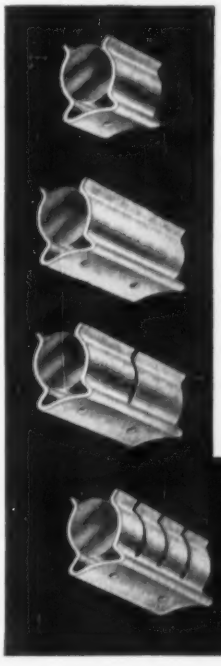

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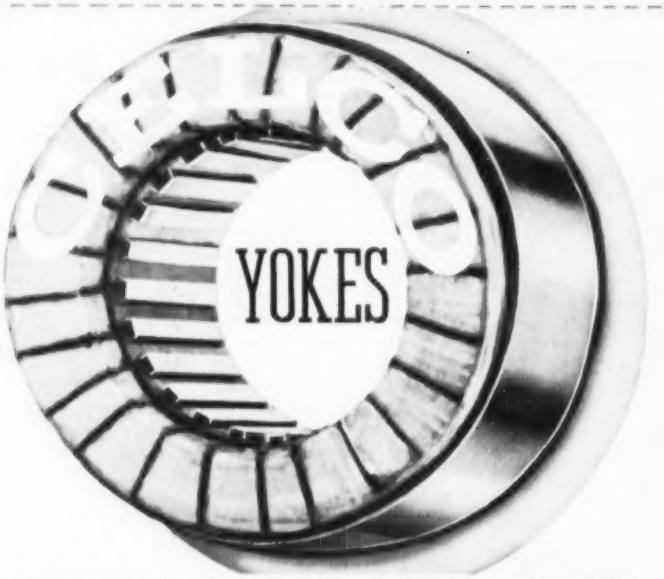

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New Jersey, plant of Synthetic Mica while retaining many of his duties with Mycalex.

Synthetic Mica's manufacturing facilities in New Jersey, were established in 1955 to provide a domestic source of mica for electrical and electronics use. The natural sources of electrical grade mica are mostly in India, Madagascar and Brazil.

Prior to his association with Mycalex Kleppinger was a vice-president of General Ceramics Corp. and a resident engineer for Ford, Bacon & Davis.

Fansteel Spurs Expansion Plans

FANSTEEL METALURGICAL CORP. will construct one new building and a third story addition to another at its North Chicago plant.

Their combined cost will be about $665,000. The new structure will contain 21,500 sq ft of floor area and will be at the firm's South plant. It will be used for production of sintered powder metallurgy products.

The third-story addition will have an area of 24,500 sq ft. It will be built on Fansteel's North plant metallurgical building and will be used for research laboratory offices, laboratories, pilot plant facilities and a library.

Electro-Instrument Adds Space

ELECTRO-INSTRUMENTS, INC. of San Diego will consolidate its operations in a 30,000 sq ft plant and office structure to be built in San Diego at a cost estimated between $350,000 and $400,000. Plans call for building to start in June with occupancy by Sept. 1 for an expected 150 employees.

The 2½-year-old plant produces digital voltmeters, recorders, in-line assemblies and precision resistors.

Milwaukee Resistor Names Chief Engineer

GEO. D. RAEBURN will serve as chief engineer and plant superin-

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tendent of Milwaukee Resistor. He was formerly with the Centralab division of Globe Union in Milwaukee in the production and engineering development department.

Polytechnic Research Appoints Finke

H. A. Finke

HERBERT A. FINKE has been advanced to general manager of Polytechnic Research & Development Co. of Brooklyn, N. Y.

He will be responsible for all phases of operation of the company, which designs and manufactures microwave and electronic test equipment and components.

He has been with the company since 1946, serving as director of engineering and manager of operations. Before that he was with RCA Laboratories and United Aircraft Corp.

Radioplane Names Vice-President

M. W. TUTTLE, vice-president of operations at Radioplane Company, has been appointed vice-president and general manager.

He will report to William Larrabee, executive vice-president of the company.

Tuttle became associated with Radioplane in 1951 as director of military relations. He was elected vice-president in 1952 and in 1954 was appointed vice-president of operations.

A native of Los Angeles, M. W.

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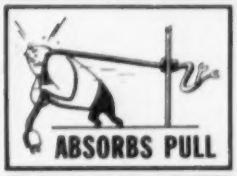

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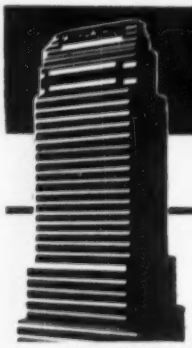

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Tuttle has been active in the field of target drones and missiles, both in the U. S. Navy and in industry, since 1942.

Radioplane Company, with headquarters and main plant at Van Nuys, also operates a division at El Paso, Texas. The company specializes in the development and production of complete target drone and missile systems for the Armed Forces.

Norden-Ketay Appoints Pierce

WAYNE M. PIERCE, JR. was appointed vice-president for engineering and manufacturing of Norden-Ketay Corporation. He joined the firm in 1951. He planned the operations layout of several of the firms plants.

In the newly created post, he will represent the president directly for all matters regarding engineering and manufacturing. He is responsible for the corporation's engineering and manufacturing plans, policies and procedures.

Altec Names Engineering Director

JOHN K. HILLIARD has been appointed director of advanced engineering at the Beverly Hills, Calif., plant of Altec Lansing. He had been acting for some time as chief engineer of sound systems.

Hilliard's new duties provide for activities in the special products field of electronics and electro acoustics, including instrumentation equipment for high intensity noise studies associated with jet aircraft and missiles, microphone systems for sound measurement, and powerful speaker-amplifier systems for reproducing these particular sound findings.

NCR Selects Director Of Research

WILBUR C. MYERS was appointed director of research for The National Cash Register Company electronics division in Hawthorne, Calif.

Myers, who moves up from the position of senior research engineer has specialized in investiga-

and application of ferroelectric materials for use as components in digital computers. Prior to joining NCR, he was manager of the ceramic department of Brush Electronics Co., in Cleveland, Ohio, where he headed engineering and production of barium titenate piezoelectric ceramics. He has also served as an engineer with the Carbide and Carbon Chemicals Corp. of South Charleston, West Virginia, and as a development chemist with the Lubrizol Corp. in Cleveland, Ohio.

Branson Moves Into New Quarters

BRANSON INSTRUMENTS and its subsidiary, Branson Ultrasonic Corp. moved into a brand new plant in Stamford, Conn. This gives the company some 24,000 sq ft of working floor space, more than twice that available in two old plants.

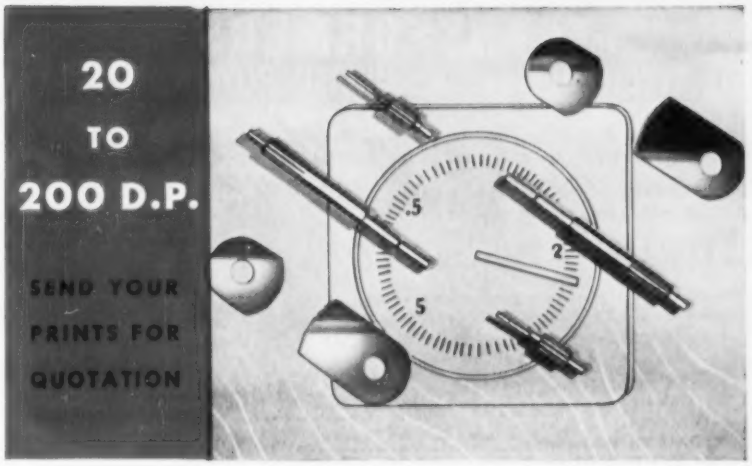
This latest move is another in a series of expansions for Branson. Starting in two rooms of an old frame house, a little over ten years ago, the company has been rapidly and continually growing ever since. Whereas it was a two-man organization when it started ten years ago Branson employs more than sixty today.

Daystrom California Selects Taylor

Charles F. Taylor

CHARLES F. TAYLOR joined the systems division of Daystrom, Inc., as a systems engineer.

He was with the United States Air Force Cambridge Research



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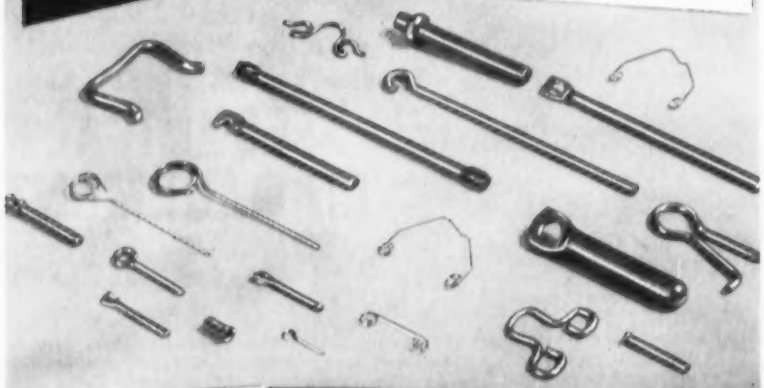

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Center at Bedford, Mass., where he worked on the formulation of the BADGE development plan and served on the data processing guidance and control sub-committee of General Powers' long range planning group.

While at Cambridge, Dr. Taylor investigated nonlinear techniques for sampled-data systems as applied to "track-while-scan" radar and weapon control computers. Prior to that, at Varian Associates, he worked on pulse circuits design and theoretical electromagnetics.

Dalmo Victor Promotes Walters

GLENN A. WALTERS, director of research at Dalmo Victor Co., has been named a vice-president of the firm.

He will continue his present duties in the company's engineering division where he heads the research laboratory staff of 75 employees.

Walters joined Dalmo Victor in 1947 as an electrical design engineer and was appointed director of research in 1950. Before joining DV he was a research associate at Stanford University where he climaxed his study of networks with construction of a wave guide simulator.

Boeing Sells Computer to Western

AN analog computer enterprise developed by the Boeing Airplane Co. has been sold to Western Electronic Supply Co. of Seattle.

Boeing first manufactured the computer in 1949 for company use when machines of the type needed were not commercially available. Western Electronic Supply now has full rights to manufacture and sell the machine.

Aarons Joins Bjorksten Labs

MELVIN W. AARONS joined the technical staff of Bjorksten Research Laboratories as senior physicist in the solid state physics section.

He was previously associated with

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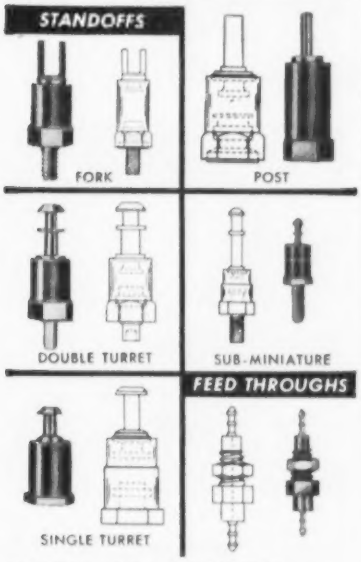

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Armour Research Foundation and Battelle Memorial Institute. His work with these organizations included direction of research in transistor metallurgy, surface passification problems with germanium and silicon, and properties of crystal imperfections in silicon and certain inorganic explosive crystals. He is also experienced in electron paramagnetic absorption and infrared polariscope techniques.

Magnetic Amplifiers Opens Western Plant

MAGNETIC AMPLIFIERS of New York City, formed a new West Coast division. The new plant is located in El Segundo, Calif. Engineering and production of magnetic and transistor servo amplifiers, power supplies, voltage regulators and airborne servo systems will be accomplished at the west coast facility.

The West Coast Division is headed by Morris R. Beard, general manager, William J. Muldoon, chief engineer and Harry A. Remer, sales manager.

Ortman Named Stanford Director

FRED B. ORTMAN has been appointed associate director of Stanford Research Institute.

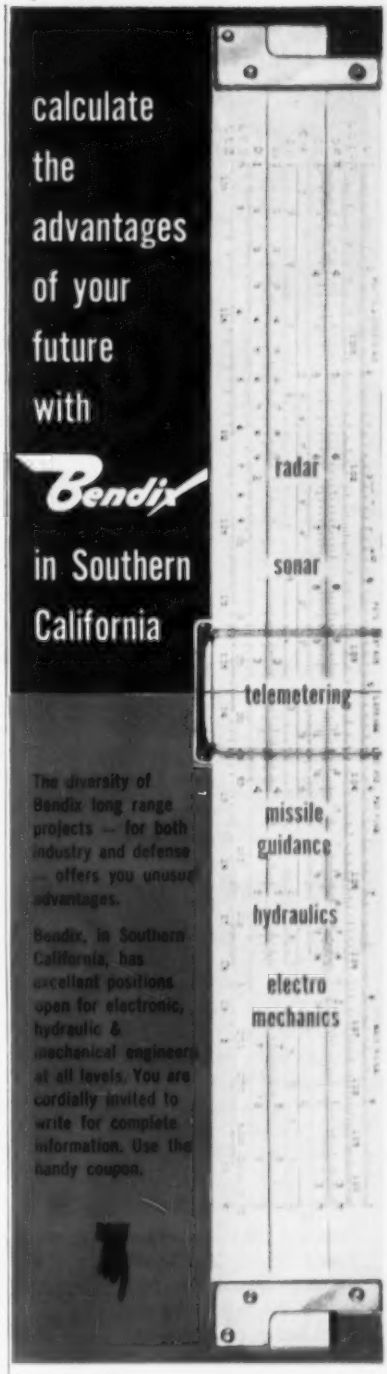
Recently retired as chairman of the board of Gladding, McBean and Co., Ortman is a member of the board of the Air Pollution Foundation, and also will continue to serve as a member of the board of directors of SRI.

He became vice-president of Gladding, McBean in 1923, president in 1938, and chairman of the board in 1953.

New Firm Formed In Waltham, Mass.

NEUTRONICS RESEARCH CO., NRC, has been formed in Waltham, Mass. It is engaged in research and development of scientific equipment in the general field of physics with particular emphasis on electronics.

The key personnel of the new firm include the three partners who own it. They are Harry Stockman, H.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Convair-Astronautics Becomes A Division

J. R. Dempsey

K. J. Bossart

CONVAIR-ASTRONAUTICS is now a full operating division of Convair division of General Dynamics Corp.

The Astronautics operation, which stems from a ballistic missile research program started by Convair and the Air Force 11 years ago, is doing research in the field of space travel as well as on the Air Force missile program. It's major propect at present is the Atlas intercontinental ballistic missile.

Later this year Astronautics will move into a $40 million plant under construction north of San Diego. It now occupies part of the Convair-San Diego plant. Payroll for the Astronautics operation includes 6,000 workers at San Diego plus several hundred at test sites at Sycamore Canyon and Edwards Rocket Base, Calif. and Patrick Air Force Base, Fla.

J. R. Dempsey, who has headed the Atlas program since 1954, is manager of the new Astronautics division.

K. J. Bossart, formerly chief engineer, was moved up to technical director. Mortimer Rosenbaum becomes chief engineer, and H. R. Friedrich, former chief flight mechanics engineer, takes over Rosenbaum's former post of assistant chief engineer, development. Krafft A. Ehricke, who was chief of preliminary design and systems analysis, is now assistant to the technical director.

Mincom Moves To New Plant

THE Mincom division of Minnesota Mining and Manufacturing Company, makers of wide-band magnetic tape systems, completed its move to new quarters in West Los Angeles.

Mincom division, formerly the electronics division of Bing Crosby Enterprises, is a recent addition to the growing list of subsidiaries of the 3M Company. Mincom designs and manufactures specialized machines capable of a recording and reproducing the high frequency signals of radar, spectrum monitor-

New Mincom plant

ing, telemetering and closed circuit television in color or black and white.

In addition the division has served as a testing laboratory for new types of magnetic instrumentation tape.

Borg Selects New President

Byron C. Booth

BYRON C. BOOTH has been elected president of The George W. Borg Corp. of Delavan, Wisc. and G. Marshall Borg was elected vice-chairman of the board of directors.

George W. Borg, who previously held the offices of chairman of the board and president, will devote more of his time to corporate policies of the company. He will be assisted by G. Marshall Borg.

Booth joined The George W. Borg Corp. in 1945 as division manager of the Borg equipment division and in 1954 was elected division president and a member of the board of directors. Previously he was vice-president of the Doyle Manufacturing Co. of Syracuse, New York and has been associated with the Norge division of the Borg-Warner Corp.

Sperry Forms New Divisions

Two new divisions of Sperry Gyroscope Co.—an Air Armament division and a Surface Armament division have been formed.

The new divisions will continue their engineering and manufacturing activities at the company's main Nassau plant at Lake Success, N. Y. and at supplementary facilities scattered over Long Island

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Component Voltage At Balance	1 volt
Frequency	Either 1,000 C.P.S., or 10,000 C.P.S.
Full Scale Ranges	±5%, ±10%, ±20%
Component Test Ranges:	
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Capacitance	50 mmf - 20 mfd
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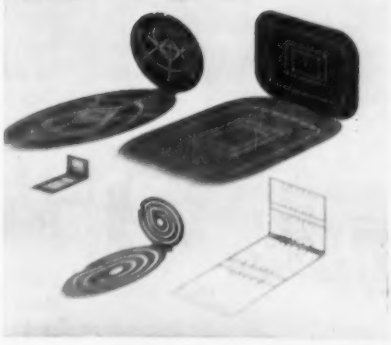

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Insertion Loss — less than 1.5 db

Maximum VSWR — less than 1.25 at 4,000 mc.

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Weight — 8 ounces

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and other sections of the country.

Samuel Agabian, former works manager, was named as manager of the air armament division and Myron D. Lockwood, former engineering director of surface systems, was named as manager of the surface armament divisions. Both groups list classified guided-missile projects among current development and production assignments in air and surface categories.

Eitel-McCullough Appoints Welch

JAMES R. WELCH has been named manager of application engineering for Eitel-McCullough of San Bruno, California, manufacturer of Eimac electron power tubes.

Welch joined Eimac in 1950 as a research engineer in the firm's laboratory, transferring to the application engineering in 1955. Prior to joining Eitel-McCullough, he spent two years as a maritime radio operator, worked seven years as transmitting engineer for Press Wireless and Globe Wireless in San Francisco, was a specialist in radio direction finding during three year's Coast Guard Service and was employed for five years in the radio broadcasting field.

James R. Welch

Sylvania Forms New Lab and Division

A NEW reconnaissance systems laboratory has been established at Mountain View, Calif. by Sylvania Electric.

The new laboratory will be engaged in research and development work on new techcniques and electronic systems for intercepting radio signals.

Concurrent with the formation of the new laboratory, the new activity and two existing laboratories have been organized as the Mountain View systems laboratories. Included in the new organization are the electronic defense laboratory and the microwave physics laboratory.

A fourth facility at Mountain View, the microwave tube laboratory, continues as a separate activity of the electronic systems division.

"The establishment of the reconnaissance systems laboratory and the reorganization of the Mountain View facilities reflect the rapid growth of our systems activities on the West Coast," Mr. Lehne said. He noted that about 50 professional scientists and engineers will be employed in the reconnaissance systems laboratory during the first year.

Samuel A. Ferguson, formerly head of the electronic defense laboratory, has been named manager of the Mountain View systems laboratories.

Walter Serniuk, who was previously manager of the engineering development department of the electronic defense laboratory, has been appointed manager of the reconnaissance systems laboratory. Jesse R. Lien is the new manager of the electronic defense laboratory, in which he was formerly manager of the systems and projects department.

Bendix to Enlarge Friez Facilities

FRIEZ INSTRUMENT division of Bendix plans to build a new manufacturing, engineering and research facility, part of a million-dollar expansion program.

The new facility will add 66,000

sq ft to the present 100,000-sq-ft plant. It is being built to meet the increased demand for precision products, including meteorological and aircraft flight instruments, electro-mechanical missile components, light amplifiers and closed circuit TV systems, such as the Lumicon, as well as other complex airborne equipment.

The building is to be ready for occupancy in December, 1957.

Gavitt Wire Builds Plant

GAVITT WIRE AND CABLE CO., a division of the American Hard Rubber Co., plans to construct a 35,000 sq ft wire and cable manufacturing plant in Escondido, Calif. Construction on the 12 acre plot is scheduled for completion in June, 1957, at a cost of some three quarters of a million dollars. The firm makes precision fine wire and cable.

Teller Appoints Research Consultant

Albert G. Thomas

ALBERT G. THOMAS has been appointed research consultant of The Teller Co. of Butler.

Previously he served as head of the department of engineering research and development of the Industrial Research Institute of the University of Chattanooga.

His new assignment is directed toward patent work and research projects related to Digitork, a control system for automation.

Thomas is the inventor of the motor around which the Digitork system is built. Teller has been

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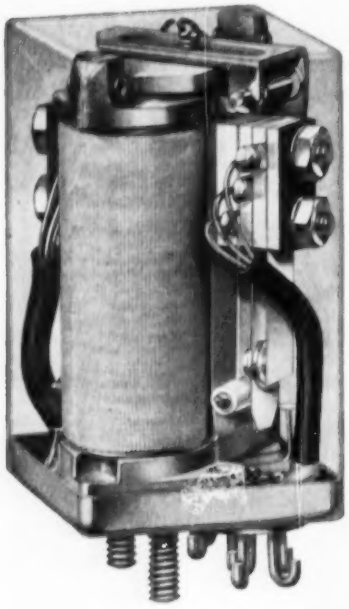

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awarded exclusive manufacturing and sales rights for this new system for the Industrial Controls Corp. of Chattanooga, Tenn.

He was in charge of patent work for division 4 of the Office of Scientific Research and Development prior to his association with the University of Chattanooga. During the course of his work there, he aided in the development of the radio proximity fuse.

Bell & Howell Add Space

BELL & HOWELL CO., Chicago, manufacturer of tape recorders, phonographs, radios and photographic equipment will build a $1.7 million addition to its main plant.

The 160,000 sq ft addition is near completion. It will be used for manufacturing and warehousing.

Ronette Moves To Lynbrook Plant

RONETTE ACOUSTICAL CORP. have acquired a building in Lynbrook, N. Y. and will move there from the present location in New York City.

The 10,000 sq ft plant is now being refurbished for the assembly of phonograph cartridges, tone arms and microphones.

Royal Plans Plant Expansion

ROYAL ELECTRIC CORP. in Pawtucket, R. I., newly acquired subsidiary of IT&T has signed a contract for the construction of an additional 90,000 sq ft of space to its existing plant.

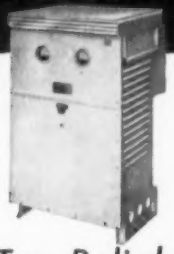
Electrodata Names Quality Manager

JOHN F. HINCHEY has been appointed quality assurance department manager for the ElectroData division of Burroughs Corp. in Pasadena, Calif.

He will be responsible for the testing, inspecting and quality control of high-speed electronic data processing systems, during the entire manufacturing operation.

Prior to joining ElectroData in

NEW CHRISTIE SILICON POWER RECTIFIERS



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Sure, an engineer's pay is good—but mine just wouldn't stretch far enough to give my family all the nice things they deserve. So in my spare time I'm servicing commercial mobile-radios in my home town. And I'm mighty proud to think of my wife driving that new Thunderbird!

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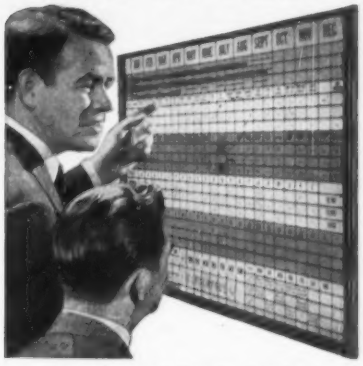

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1956, Hinchey was assistant director of quality control for Consolidated Electro-dynamics Corporation since 1953. From 1947 to 1953, he worked for Fairchild Aerial Surveys as an electrical engineer, and before this for one year was an assistant project engineer for Sperry Gyroscope.

New Firm Formed In California

A NEW electronic manufacturing firm, the Kelvin Electric Company has begun operations in recently completed facilities in Van Nuys, California.

Products of the newly organized company are precision wire-wound resistors and resistive networks.

Heading the firm are William I. Elliott and Kenneth T. Eckardt, formerly president and vice-president, respectively, of Hycor Co., Inc.

Ruge Names Chief Engineer

WARREN E. JACKSON has been appointed chief engineer of A. C. Ruge Associates. In his new capacity, he will direct the Cambridge, Mass. company's expanding program of new product development.

He formerly worked as a product development engineer in a design and development group at Arthur D. Little.

Daystrom Creates Reactor Center

A NUCLEAR REACTOR CENTER has been established in West Caldwell, N. J. by Daystrom Nuclear, a division of Daystrom, Inc.

The division's research and administrative staff will move into a 36,000 sq ft laboratory, where an "Argonaut" reactor is to be installed. Here college and university faculty members can be trained in the peacetime use of nuclear reactors. Daystrom Nuclear will go into quantity production on a 10 kw Argonaut research reactor that will be avail-

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KP-125, KP-135, KP-145 Indicators Monitor Transistor Circuits

KP-125, Actual Size

The first family of Indicator Tubes is now available in production quantities at low prices. The KP-125, already in computer transistor monitor service, is complemented by the *new* KP-135 and KP-145. These tubes satisfy differing needs for end-viewing (tip-glow), and visual brightness consistent with circuit power limitations. All tubes are grid-controlled gas triodes with 1.4 v (AC or DC) filaments, are operable from the 120 v AC line, consume low power (milliwatts), are specifically designed, and in production for transistor monitor service. Mountable in three ways for high density read-out, the KP-125, KP-135, and KP-145 eliminate the use of several components (relays, lamps, etc.) which require large voltage swings with heavy current drains which load the test circuit. The KIP Indicator Tubes take small signals (4 v), draw negligible grid current (less than 1 uA), provide visual indication, and are *AVAILABLE IMMEDIATELY* for all transistor monitor applications. *For details on these and other special purpose tubes write:*

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INSULATION AT 800°F.
HIGH DIELECTRIC COATING
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To fill a need for high temperature insulation in a high conductivity wire. Precision drawn to close resistance control in the smaller sizes.
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able to colleges, universities and industry. General manager of the division is Dr. Stephen Malaker.

Kay Lab Changes Trade Name

KAY LAB, San Diego electronic manufacturing company, has adopted a new trade name, "Kin Tel".

The new name, derived from the company's two product lines, instruments and television equipment, was made to avoid possible trademark conflict with another firm.

GE Converts TV Tube Plant To Transistors

GE will convert its 175,000 sq ft Buffalo, N. Y., tv picture tube plant to the manufacture of transistors early in 1957.

In addition to the 175,000 sq ft building in Buffalo which will be devoted wholly to transistor production, General Electric will continue to manufacture transistors at Electronics Park. The Semiconductor Products Department headquarters and engineering function will also remain in Syracuse. Production of tv picture tubes will be consolidated and ultimately expanded in the cathode ray tube department's facility at Electronics Park.

ESC Names Research Chemist

ESC CORP. of Palisades Park, N. J. specialist in delay lines, appointed Benno Heinemann as chief research chemist.

Dr. Heinemann's responsibilities will include direct supervision of the ESC encapsulation department. Previous to joining the firm, he was associated with Standard Rolling Mills. (Division of Revere Copper and Brass, Inc.), Brooklyn, N. Y.

California Firm Moves East

THE electronics division of Elgin National Watch Co. is closing its American Microphone plant at

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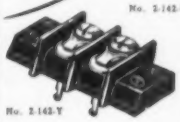

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Six series meet every requirement: No. 140, 5-40 screws; No. 141, 6-32 screws; No. 142, 8-32 screws; No. 150, 10-32 screws; No. 151, 12-32 screws; No. 152, ¼-28 screws.

Catalog No. 21 lists complete line.

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Pasadena, Calif., and will move equipment and key personnel to Elgin, Ill., for resumption of production in the near future.

A. P. Barton, general manager of the division, said the move was dictated chiefly by the need to relocate American in a centralized location for better service to the trade, although another factor was closer liaison with Elgin's central research and development laboratories.

New warehousing facilities will be established at Burbank, Calif.

Stanford Research Selects Ortman

FRED B. ORTMAN has been named associate director of Stanford Research Institute.

He recently retired as chairman of the board of Gladding, McBean and Co.

He is a past director of the National Association of Manufacturers (Los Angeles), and is currently a member of the board of the Air Pollution Foundation. He will also continue to serve as a member of the board of directors of SRI.

Hallamore Opens Branch Operation

HALLAMORE ELECTRONICS Co. of Anaheim, Calif., opened a branch at Denver to supply electronic components to the newly-opened Glenn L. Martin guided missile plant.

Electronic Specialty Appoints Martin

THE ELECRONIC SPECIALTY Co. appointed William R. Martin as chief engineer and product manager of the RF systems and components division.

He comes to the Electronic Specialty Co. from Lockheed Aircraft Corp., where from 1950, he has been in charge of the complete radiating systems group.

From 1945-1950 he was a project engineer of Airborne Instruments Laboratory.

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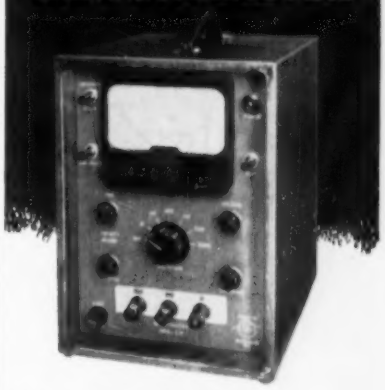

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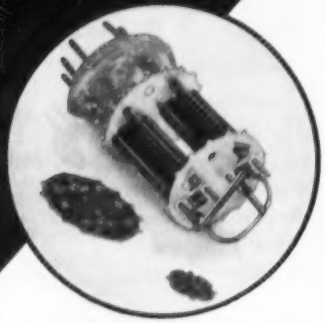

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New Books

Mathematics for Electronics with Applications

By Henry M. Nodelman and Frederick W. Smith
McGraw-Hill Book Co., Inc., New York, 1956, 376 *p*, $7.00.

Although a considerable number of books on mathematics for engineers and physicists have appeared in recent years, this book probably represents the first comprehensive attempt at an exposition on an elementary level of those branches of mathematics which have been the most useful in engineering electronics.

The subjects covered are quite large in number and include elementary calculus, dimensional analysis, determinant and matrix theory, the theory of series, differential equations, Laplace transforms and the elements of Boolean algebra. However, other subjects which are certainly of importance in electronics such as vector analysis, probability and statistical methods have been omitted.

▶ **Approach** — The authors use a pragmatic approach, whereby the applications of the various subjects are emphasized rather than their mathematical development. Thus most of the mathematics is stated without proof and augmented by numerous examples of their use.

For instance, in the exposition of linear algebra, one chapter is devoted to determinant theory and another to matrix theory. Each of these is then followed by a considerably longer chapter dealing with network analysis wherein the stated theory is illustrated.

An extensive and excellent bibliography is included and much practical information such as tables of transfer functions of R-C networks and matrices of various vacuum-tube configurations is presented. The appendix covers tables of logarithms, exponential and trigonometric functions and a list of 108 indefinite integrals. A large number of elementary problems are given at the end of each chapter.

Unfortunately the text is very sketchy in its development. Several errors were noted, such as the discussion on p 100 to 101, on how to choose mesh currents. In particular, the statement that "sufficient cyclic currents will have been introduced when some cyclic current appears in every network element or branch" is false and the subsequent discussion on network topology on p 117 to 124 does not resolve this matter.

Other examples of errors are the following: the statement on p 125 that passive two-terminal pair networks need only three independent parameters for their complete representation on a matrix basis is false. On p 137 the authors confuse dual with inverse networks, which are related but not the same.

▶ **Uses**—Except for these shortcomings, this book may be useful as an introduction to the mathematics which is encountered in electronics for those with mathematical training includes college algebra and elementary calculus.

Although its scope is too wide and its approach too elementary for it to be suitable as a text book for a college course in electrical engineering mathematics, it may be used successfully in technical schools. It should also be excellent for supplementary reading and as a source book for further study in the technical literature on the mathematics of electronics.—Armen H. Zemanian, *College of Engineering, New York University.*

Introduction to Solid-State Physics

By Charles Kittel
John Wiley & Sons, New York, 1956, 617 *p*, $12.00.

The preface to the first edition of this text contained the statement that it "is intended for senior and beginning graduate students in physics, chemistry, and engineering." Many a "student" who considered himself beyond that stage has had occasion to wonder what university contained classes of this caliber. In this second edition, experience and a laudable caution has eliminated the estimate as to

the level of students for which it can be useful; while a hundred pages of more careful explanation of basic concepts have been added. This new material, as well as considerable rearrangement of that already in the book, has immensely increased its usefulness to the learner, particularly in engineering and chemistry.

▶ **Rearrangement of Material**—For example, in place of the original first chapter of 27 pages—covering the three fundamental topics, types of solid binding, crystal structures and x-ray diffraction, about equally—there is now a sizeable chapter for each and in fact, the crystal structure chapter is more complete than anything else in the book. The approach in this chapter through two dimensions is excellent, but this reviewer would have been satisfied with a less complete treatment of actual crystal symmetries (although this material is not as conveniently available elsewhere). Another example of salutary rearrangement is that of the chapter on free electron theory of metals. In the first edition this followed the chapter on superconductivity! It began abruptly with the quantum theory of particles in a box and only mentioned ohmic conductivity in a few brief paragraphs somewhere in the middle. The present arrangement has been found to be far more satisfactory.

▶ **Background Needed**—These improvements help, but have still not completely eliminated the tendency in the first edition to start from what often appeared to the beginner to be the middle of the subject. In fact, this book will still be hard—but not impossible—going for those without some understanding of modern physics. For those who do already have this understanding, this edition, like the first, is a treasuretrove of unexpectedly simple and physical approaches to a difficult subject. With the addition of a hundred pages of extra material, it also continues to increase its standing as a necessary reference for those already in solid state work.

The need remains for a really elementary treatment of basic ideas in solid-state physics. Meanwhile, this greatly improved book will

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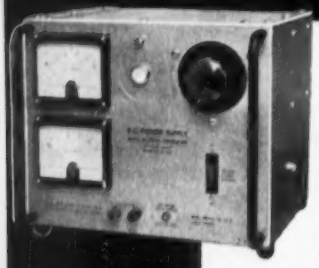

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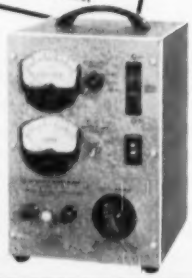

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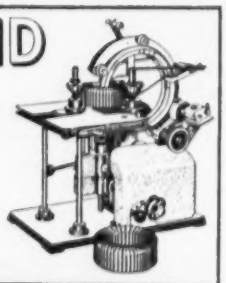

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have to satisfy this need, as well as the one it does fill well for a single book through which one can become acquainted with most of the modern ideas in the field, so many of which are taking on increasing technical importance. There is little prospect that any book will replace it in this respect, whether for physicists or electronic engineers.—*P. W. Anderson, Bell Telephone Labs., Inc., Murray Hill, N. J.*

Transistor Engineering Reference Handbook

By H. E. Marrows
John F. Rider Publisher Inc., New York, 1956, 288 p, $9.95.

The rapid growth of transistor technology has led to an increase in transistor literature. "The need to assemble and coordinate information on all the commercial aspects of the industry under a single cover" led to the writing of the Transistor Engineering Reference Handbook. To achieve his purpose the author has divided his book into five sections.

▶ **Context**—The first section (32 p) is a brief general survey of transistors that includes a chronology of transistor developments, a presentation of device characteristics of junction transistors and a review of transistor materials, structures and techniques of fabrication. The next section, by far the major portion of the book (202 p) contains specification sheets on commercial transistors. The third section (16 p) has reference data on transistor auxiliary equipment. Here transformers, capacitors, batteries, thermistors and test sets are briefly collected and described. The fourth section (22 p) attempts to review the commercial applications of transistors, while the last section is a four-page directory of manufacturers.

The material covered in the book is quite recent. The transistors covered are to mid-1956 and the components seem to be up-to-date to early 1956.

The student or engineer just beginning to look into the transistor field will find much material normally gathered by contacting the

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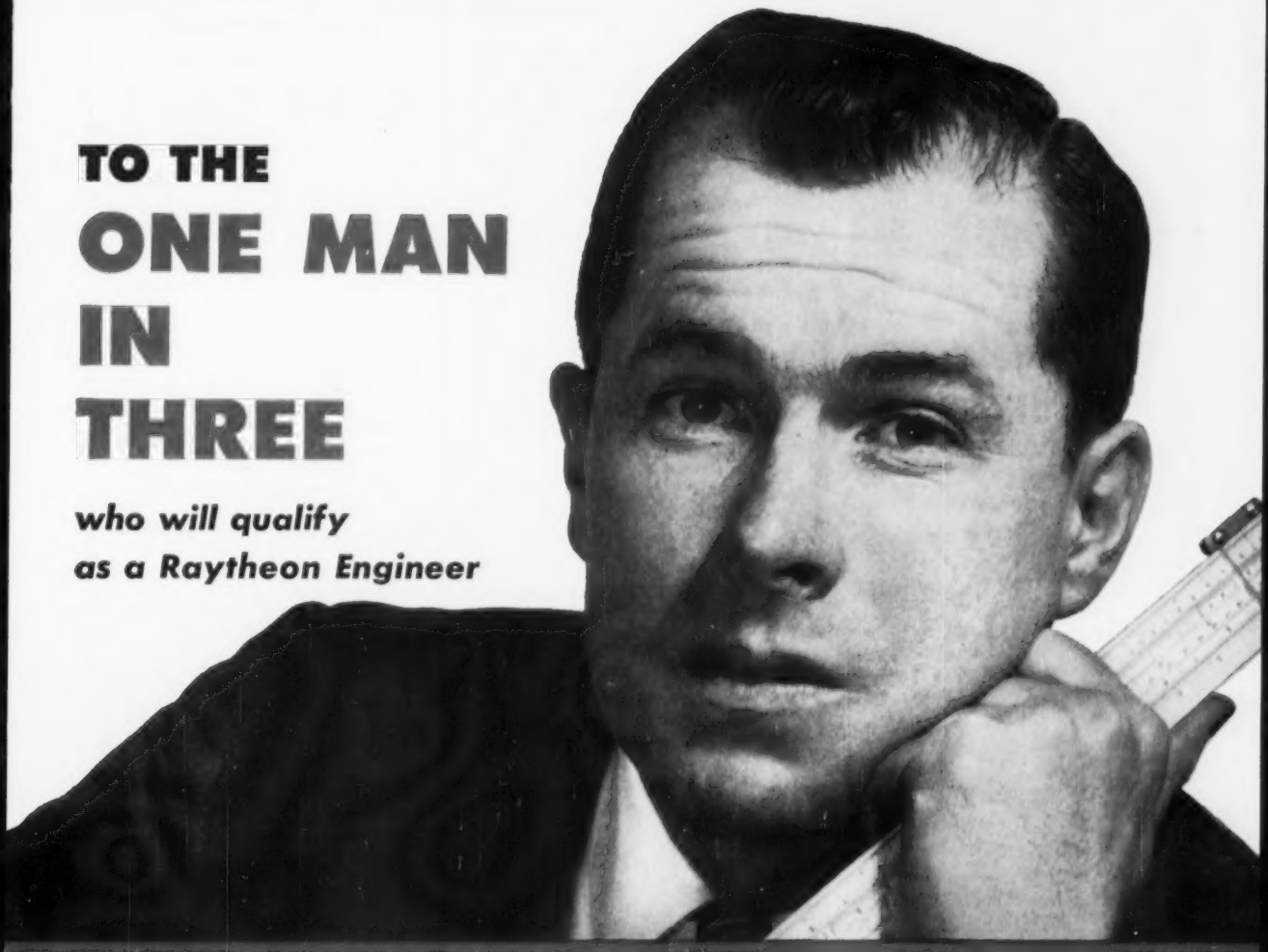

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various manufacturers. The engineer in the field will have acquired most of the material in the course of his work.—F. BRONSTEIN, *Design Engineering Dept., Ford Instrument Co., Long Island City, N. Y.*

Applied Electrical Measurements

BY ISAAC F. KINNARD with 14 contributors.
John Wiley & Sons, New York, 1956, 600 *p*, $15.00.

COVERING many aspects of modern measurements, Dr. Kinnard has written a book which should make good reading for the advanced engineering student and the newcomer to the phase of electrical engineering activity which is concerned with measurements. In the preface the author states that he intended his book to be useful to the scientist, engineer, technician, and student alike whenever they have a measurement problem. Appealing uniformly to such a heterogeneous group of readers is difficult, however.

"Applied Electrical Measurements" covers broadly many of the commonly employed electrical measurement devices and their application to the measurement of electrical and nonelectrical quantities.

▶ **Electrical Quantities** — Part I, consisting of slightly more than one half of the book, is devoted to the measurement of electrical quantities. The author presents some historical material and then delves into systems of units. In addition to electrical units, mechanical and thermal units are discussed.

The instruments and techniques used for the measurement of the basic electrical quantities (current, potential difference, resistance, etc.) are treated and, in addition, such topics as phase angle, power factor, synchronism and frequency, waveforms and magnetism are covered. High-frequency and microwave measurements are not included in the book.

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schematics. His expositions are lucid and a reader without much background in electronic circuits will gain insight into the basic working principles of common laboratory instruments. This reviewer felt that more extensive references to commercially available instruments of different manufacturers would have made the book more useful.

▶ **Nonelectrical Quantities** — Part II is devoted to the measurement of nonelectrical quantities by electrical means. With the increasing application of electronic control systems in many industries the monitoring of nonelectrical quantities by electrical means has become widespread. The chapter headings, light, heat, sound, statics and kinetics, liquids and gases and time convey best the nature of the material covered.

As in previous chapters the author covers only the basic measurement methods. Typically, a major topic is introduced by a discussion of applicable physical laws followed by a critical examination of units of measurement as well as standards.

Coverage of several measurement techniques and instruments followed by a bibliography might conclude the chapter. The bibliographies which are presented in each of the 18 chapters provide a convenient guide to further reading matter.

Dr. Kinnard's well-written book offers a comprehensive introduction to many important measurement methods.—HENRY J. BICKEL, *Columbia University, Electronic Research Laboratories, New York, N. Y.*

Professional Engineer's Examination Questions and Answers

By WILLIAM S. LA LONDE, JR. *McGraw-Hill Book Co., Inc., New York*, 1956, 462 *p*, $6.50.

BOTH the recent graduate and the practicing engineer, in all branches of the profession, will find this book useful in reviewing engineering fundamentals for professional engi-

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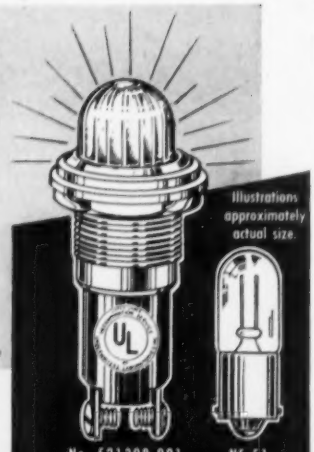

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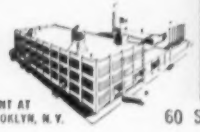

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neer's licensing examinations in various states.

From the 500 or more problems in this book, about 80 percent were taken directly from sample questions or past examinations of state boards of examiners throughout the United States. The problems do not represent the questions of any one state, but rather a composite.

▶ **Material Reviewed** — The questions and answers covered include basic fundamentals, chemistry, science, materials, electricity, hydraulics, mathematics and measurements, mechanics, thermodynamics, chemical engineering, civil engineering, electrical engineering, engineering economics and business relations, mechanical engineering, structural engineering and land surveying.

As an aid to filling out applications for licenses, the author devotes a section of the book to evaluating different types of work experience. Jobs in the various branches of engineering are broken down into listings of professional and subprofessional experience. Another convenient reference is a list of names and addresses of registration boards in the United States, Alaska, Hawaii and Puerto Rico. —H.A.M.

Thumbnail Reviews

Direct-Current Machines (Second Edition). By Liwschitz-Garik and Whipple, D. Van Nostrand Co., Inc., Princeton, 1956, 307 p, $6.25. Rearranged edition with material divided into two parts, one, dealing rigorously and competently with fundamentals, is for conventional undergraduate ciriculums and other part is devoted to detailed consideration of specialized topics of interest to postgraduate students as well as practicing engineers.

Trigonometry Refresher for Technical Men. By A. A. Klaf, Dover Publications, Inc., New York, 1956, 629 p, $1.95. Question and answer text covering important aspects of plane and spherical trigonometry. Application problems in navigation, surveying, elasticity, architecture and various fields of engineering are covered.

Calculus Refresher for Technical Men. By A. A. Klaf, Dover Publications,

Inc., New York, 1956, 431 p, $1.95. Examination of more important aspects of integral and differential calculus in terms of questions and answers. Practical aspects rather than theoretical are stressed.

Proceedings of the Conference on Radio Interference Reduction, Vol. I and II. Armour Research Foundation, Dept. E, Chicago, 1954 and 1956. $3.00 per set. Material of interest to both manufacturers and research and development laboratories includes measurements, design techniques, practical suppression measures and component development. Equipment and systems covered encompass radio, radar, aircraft, missiles, vehicles and electrical devices.

Das Ohr Als Nachrichtenempfanger (The Ear as a Receptor of Information). By Richard Feldtkeller and Eberhard Zwicker, S. Hirzel, Stuttgart, 1956, 86 p. An attempt to assemble all the known data on the subject into one volume. An excellent discussion is given of the perception of frequency by the ear and of the ability of the ear to distinguish sounds of nearly identical pitch.

Radio Valve Data, Fifth Edition. Iliffe & Sons Ltd, London, 1956, 126 p. Characteristics and base connections, in tabular form, of approximately 2,500 British and American tubes and 37 transistors, with index and table of British-American equivalents. May be ordered from British Radio Electronics, Ltd., 1833 Jefferson Pl., N. W., Washington 6, D. C.

Radio-Television and Basic Electronics. By R. L. Oldfield, American Technical Society, Chicago, 1956, 342 p, $4.95. Textbook for technicians, servicemen and amateurs covers range from basic theory to circuitry, including f-m; sound systems; b & w and color tv; transistors; etc. Glossary, conversion table, letter symbols and electronic symbol table are included.

Subcontracting Policy in the Airframe Industry. By John S. Day, Harvard Business School, Division of Research, Boston, 1956, 327 p, $4.00. Growth of subcontracting in airframe industry, legal and nonlegal connotations in being subcontractor, possible substitutes for subcontracting and problems in formulating a subcontracting policy.

Asymptotic Expansions. By A. Erdelyi, Dover Publications, Inc., New York, 1956, 108 p, $1.35. Short tract on asymptotic expansions and their applications to the solutions of ordinary linear differential equations based on lecture notes given to graduate mathematics students. Subjects cov-

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ered are asymptotic expansion of functions defined by integrals, singularities of differential equations and the solutions of second order differential equations having a parameter whose values are large.

Introduction to Distributed Amplification. By Harry Stockman, Ser Co., 543 Lexington Avenue, Waltham, Massachusetts, 1956, 240 p, $2.90. General principles of distributed amplifiers, analysis of its operation including cutoff prediction and filter theory, and synthesis considerations including parameter calculations, use of transistors, cascading of stages and general network synthesis methods. Fairly large appendix is concerned with many fundamental considerations upon which previous discussion was based.

Transistor Techniques. Gernsback Library, Inc., New York, 1956, 96 p, $1.50 (soft cover). Practical information for transistor users on identification of unknown transistors, measuring transistor characteristics, etc. Several circuit applications are covered.

Electronic Metal Locators. By Harold S. Renne, Howard W. Sams & Co., Inc., Indianapolis, 1956, 117 p, $2.50 (soft cover). Operation and application of various types of metal locators in prospecting and in industry. How to build your own section is included.

Servicing TV AFC Systems. By John Russell, Jr., John F. Rider Pub., Inc., New York, 1956, 128 p, $2.70. Troubles, location and repair of afc circuits for tv technicians.

Pictorial Microwave Directory. By V. J. Young and M. W. Jones, John F. Rider Pub., Inc., New York, 1956, 116 p, $2.95. Derivation, explanation, definition and illustration of various microwave terms for engineers, students and technicians.

Fundamentals of Electrical Engineering—Vol. II: Alternating Current Engineering. By Hans Teuchert, Fachbuchverlag, Leipzig, East Germany, 1956, 371 p, DM12.80. Reference book covering phenomena and interrelations of a-c engineering and determinative factors in a-c circuits. Available through bookstores only.

Proceedings of the RETMA Symposium on Reliable Applications of Electron Tubes. Engineering Publishers, GPO Box 1151, New York 1, N. Y., 1956, 105 p, $5.00. Compilation of 15 technical papers presented at Philadelphia on May 21 and 22, 1956.

Relaxation Methods in Theoretical Physics, Vol. II. By R. V. Southwell, Oxford University Press, New York, 1956, 522 p, $8.80. Final volume of series of two covers equations of or-

ders higher than second, equations with three independent variables and nonlinear equations. Three-dimensional relaxation, heat conduction and other transient problems are also covered.

The Gramaphone Handbook. By Percy Wilson, Methen & Co Ltd, London, 1957, 227 p, 15 s. Introduction to high-fidelity equipment for nontechnical readers covering individual components, complete systems and general philosophy.

Repairing Television Receivers. By Cyrus Glickstein, John F. Rider Publisher, Inc., New York, 1957, 212 p, $4.40. How to diagnose and troubleshoot faulty television receivers by localizing defective sections and components.

Handbook of Basic Circuits. By Matthew Mandl, Macmillan Co., New York, 1956, 365 p, $7.50. Circuits used in a-m, f-m and tv applications are listed alphabetically in dictionary style. Each of 136 listings includes circuit diagram, characteristics, function and applications.

Resonant Circuits. Edited by Alexander Schure, John F. Rider Publisher, Inc., New York, 1957, 72 p, $1.25 (paper). Introduction to series and parallel resonant circuits for engineering students and technicians.

L-C Oscillators. Edited by Alexander Schure, John F. Rider Publisher, Inc., New York 1957, 72 p, $1.25 (paper). Introduction to L-C oscillator circuits for engineering students and technicians.

Electronic Digital Computing and Information Processing. Edited by Johannes Wosnik, Friedr. Vieweg & Sohn Verlag, Braunschweig, 1956, 229 p. A collection of papers presented at the International Computer Conference held in Germany in October 1955. Majority of papers are in German with a few in French and English. Topics considered include computer developments, circuitry, storage techniques, programming and numerical methods.

The United States Air Force Dictionary. Edited by W. A. Heflin, Air University Press, 1956, 578 p, $4.00. Order from Supt. of Doc., U. S. Govt. Printing Office, Washington, D. C. Covers that part of the English language related in some significant way to the Air Force, including airborne electronic terms and guided missile terms.

Hi-Fi Handbook. By William F. Boyce, Howard W. Sams & Co., Inc., Indianapolis, 1956, 224 p, $3.00. Theory, equipment selection considerations and system arrangement are the general areas of coverage of this book for audio enthusiasts.

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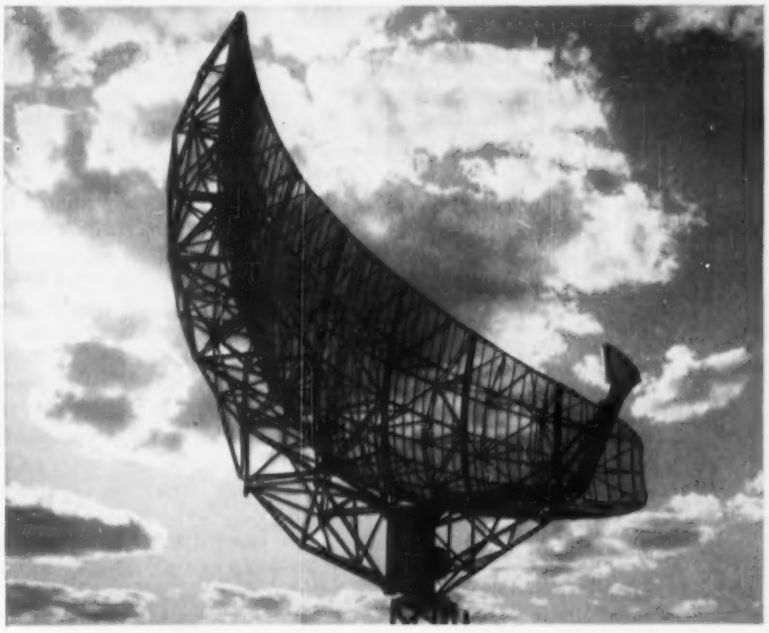

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Backtalk

New Gravitation Theory Proposed

DEAR SIRS:

VARIOUS stabs at gravitation have been made in this corner of science and it is natural that most readers of ELECTRONICS are inclined to use electromagnetic fields as the basis for their considerations. Possibly, this attitude is correct, possibly not, and to introduce a different train of thought excerpts from the paper "Report on Fundamental Physics" published by the writer three years ago are presented below:

The general opinion exists that gravitation results from attraction which supposedly is inflicted by every object upon all other objects in the universe. In other words, the smallest, as well as the largest object of the universe is supposed to draw toward itself all other objects with the help of a certain something which it conceivably possesses.

No logical explanation of this something, and of its mode of action has been published so far and nothing could be found representing a satisfying answer in regard to "attraction", despite search throughout many years. The supposition of attraction as the cause of gravitation was therefore discarded and it was investigated what effect a force field, filling the entire universe, could have in regard to gravitation. This led to the conception of "appulsion" which is supposed to be an occurrence causing the drifting of one object toward another object.

The conception of appulsion presupposes the existence of a field of free quanta, filling the entire universe, which might be considered either as matter quanta or, as energy quanta, which move in a generally straight line, which penetrate all agglomerations of matter and which are absorbed by matter agglomerations in small quantities without noticeably raising their temperature. This latter restriction is intended to express that so far no contribution to the preservation or to the increase of the heat content of the large bodies of the universe was attributed to the cause of gravitation. It is possible that the lightether field represents this required field of quanta. On the other hand, a field of a still lower order may exist and in justice to all possibilities, the here presupposed field will be designated as the "field of protoquanta".

If the field of protoquanta exists, then the endeavour of two objects towards unification is caused by common action between the field of protoquanta and the objects.

This common action between the field of protoquanta and the objects derives from the absorption of protoquanta by the objects.

This absorption of protoquanta by the objects is accompanied by pressures upon the objects in the direction of the motion of the absorbed protoquanta.

The difference of absorption pressures acting upon the same object in opposite directions is the magnitude of the appulsion, acting upon the objects. Sole recognition was given so far to the effect of absorption. It is however possible that a certain percentage of the invading protoquanta is subject to reflection. Should this prove right then, a common action of absorption and reflection could generate additional appulsion.

The possibility of explaining the conception of appulsion in a simple, correct and popular manner seems hardly to exist. Therefore a false example will be used which has the advantage of simplicity and popularity, and should satisfy superficial purposes.

Lifeless objects float well apart on a pond and boys with slingshots surround this pond hurling steadily peas toward the objects. Should this procedure be choiceless then the boys will hit more often the objects closer to them than the objects farther away. This should consequently cause the objects to drift together. This latter occur-

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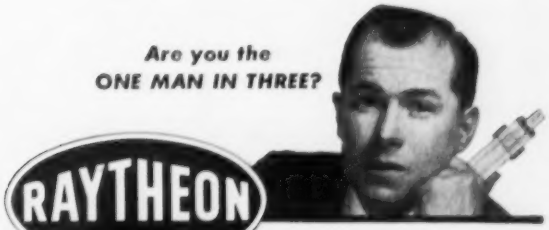

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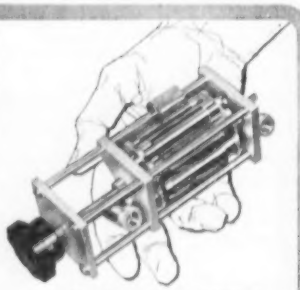

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rence is here designated as appulsion.

The flying peas present a field of energy quanta, or a field of mobile matter quanta which, in conjunction with the resiliency of the objects, causes their appulsion.

CARL P. HEINTZE
Amityville, N. Y.

Special Components

DEAR SIRS:

IN the experimental research work of this laboratory and in the r and d work I do as an outside consultant in electronics, I have continuously found the need for a service which I feel ELECTRONICS could ideally provide.

The small volume user (and there are many in this industry of high quality and low quantity) is faced with a problem the large mass producer does not have. We find a need for a special component. We know just what it should look like and what it should do. We also feel that there ought to be a profitable market for such an item with other users.

There may be several score of manufacturers capable of fabricating this item. For various reasons only certain ones would be interested. We don't know who they might be and can't contact them all.

Moreover, someone may have already done preliminary work on the project but hadn't publicized it and hadn't received any interested inquiries, but we don't know who he is. Someone may even manufacture the component but not list it in the catalog; this happens frequently.

I feel I know the component industry very well, indeed, but I don't know everything (nor does anyone else). The large manufacturer does not face this problem. If he guarantees to purchase enough, anyone would be interested.

What is needed is a common meeting ground; a "marriage-broker", if you wish. I should like to elect ELECTRONICS . . . For example, we are currently in need of a multi-turn noninductive pot of decent linearity (50,000 ohms) for use in an exponential waveform generator. Is anyone interested? Perhaps some manufacturer has wondered the same.

We hear much about the engineer shortage. It is real. Any manufacturer would be happy to at least consider the free engineering suggestions and ideas he would obtain from such a service.

For example, I have long wondered why no one combined the resistance element idea in the molded carbon pot with the long rectangular case style as used in the trimmer potentiometers. The wire-wound types are badly lacking in resolution and the carbon film ones won't handle any power. A molded carbon element ought to be good for at least twice as much as well as being adaptable to manufacture in low resistances.

The above is only an example. I have others. Any r and d engineer has many ideas that neither he nor his employer is either capable or interested in carrying through. They would be glad to pass them on in the hope that they would be able to buy the product. This could be a stimulus to the whole industry if someone would provide the forum.

GEORGE P. ANDERSON
Brown University
Providence, Rhode Island

Sinor Poesy

DEAR SIRS:

MR. FELLHAUER'S lyric in the January 1, 1957 issue of ELECTRONICS was fine; let's use the "phasor", but what about its poor cousin the "sinor", which is a special form of the phasor. The sinor is the one that really needs a shot in the arm, the sooner the better.

My only claim about the following lines is that they are original with me.

After many long years
we have sharpened our ears
to the learned voices of science:

To eject from steady-state
with frustration and hate
the vector, to show defiance!

In throwing it out

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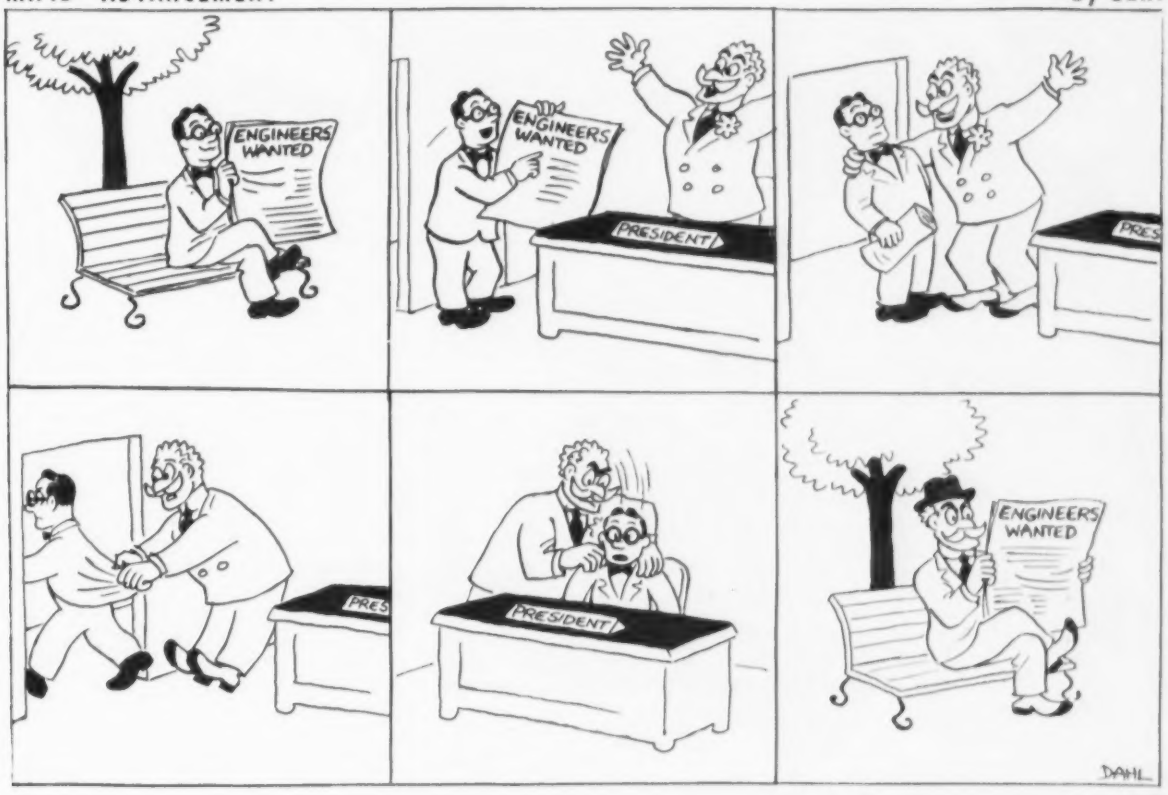

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the new term to take its place,

if unwisely chosen
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it yields another confusing
case,

for in nine of ten cases
the engineer in his paces
cares little or nothing about
the winner,

what he needs is the SINOR,
'though still a minor,
standardization not reaching
the sinner

(i.e. the sinor).

The most useful definition of the phasor appears to be a generalized one; variational or constant length, variational or constant angular velocity, so that it can be used for transients. Otherwise we will soon have to introduce still another quantity for that purpose.

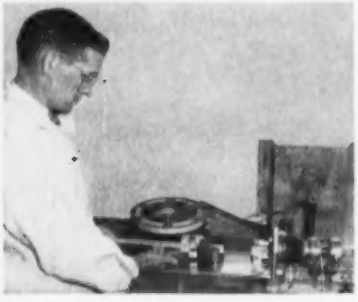
The sinor is then a natural for a-c engineering, particularly if its length is the maximum value, not the rms value.

HARRY STOCKMAN
Neutronics Research Co.
Waltham, Massachusetts

Editor's Note:

Not being a poet,
and readers all know it,
We like the word sinor,
Congrats to the rhymer!

Fast Duplicator



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TEST ENGINEERS

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Investigate the Environment created at AC for its Advanced Development Programs on Missile Guidance and Aircraft Fire Control Systems.

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Mr. Cecil E. Sundeen, Supervisor of Technical Employment

THE ELECTRONICS DIVISION

GENERAL MOTORS Corporation

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ENGINEERS & PHYSICISTS—

- Getting lost in a large organization?
- Are your engineering talents being wasted?
- Interested in a company owned and operated by engineers?

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Positions now open at all levels for electronic and mechanical engineers in the following fields:

Servos ● Antennas ● Microwaves ● Pulse Circuitry ● Receivers
Countermeasures ● Electronic Packaging ● Pedestal Design

For further information—contact: L. Billig, Chf. Eng.

GENERAL ELECTRONIC LABORATORIES, INC.

18 Ames Street ● Cambridge, Mass.

REPLIES (Box No.): Address to office nearest you
c/o This publication Classified Adv. Div.
NEW YORK: P. O. Box 12 (36)
CHICAGO: 520 N. Michigan Ave. (11)
SAN FRANCISCO: 68 Post St. (4)

POSITION VACANT

Want Salesman for mobile communication equipment in Denver area, selling major line equipment for established engineering, sales and maintenance company. Radio Specialists Co., 2620 Larimer, Denver, Colorado.

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If you have faith in your ideas and confidence in your ability to make them work, a rewarding career can be yours at Goodyear Aircraft. Our continued growth and diversification have required expansion of our engineering staffs in all specialties at both Akron, Ohio, and Litchfield Park, Arizona. Available for your use are the most modern engineering and research laboratories, including a large computer laboratory.

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For further information on your career opportunities at Goodyear Aircraft, write: Mr. C. G. Jones, Personnel Dept., Goodyear Aircraft Corporation, Akron 15, Ohio.

They're doing big things at

GOODYEAR AIRCRAFT

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If you'd like to combine the advantages of living in the Middle West and an unparalleled chance for professional growth with one of the world's foremost missile builders, just mail the coupon today for your copy of the booklet "Your Future in Guided Missiles".

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Dr. L. F. Hanson

OPERATIONS RESEARCH OFFICE ORO

The Johns Hopkins University

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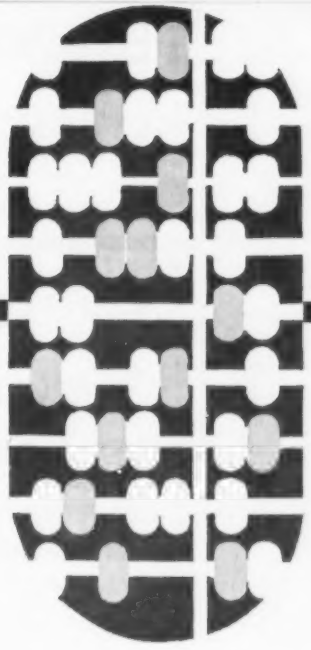
Chevy Chase, Maryland



ENGINEERS • SCIENTISTS

EVER TRY TO ADD TWO 22-DIGIT NUMBERS IN 5 MICROSECONDS?

Or multiply them – in 10 microseconds?

Well, that's exactly what Sylvania is doing — or to be more accurate, Sylvania is building a large-scale digital computer to do just that. It seems there is no existing computer that operates fast enough to simulate the flight of today's supersonic jets.

These special speeds call for a number of other important engineering developments. For example, into this new computer must be built a magnetic core memory system with a 5 microsecond repetitive random access time!

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Check the list of current openings. Decide which interests you most, and then let us hear from you.

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Write to D. R. GARVEY
Manager Employment, Dept. E

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we're in Milwaukee so we ought to know!

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P.S. AC's Permanent Expanding Electronic Program provides openings for more Mechanical, Electrical Engineers and Engineering Technicians. Even "square pegs" are provided "square holes" at AC.

Write today in strictest confidence to my friend,
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*AC THE ELECTRONICS DIVISION
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• • • to design circuits and set-up design criteria for advanced solid-state digital computing systems.

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• • • to define and develop specialized test equipment for large digital computer.

• • • for spec writing relating to materials, components and equipment.

• • • with some experience in Mechanical Engineering, to coordinate in the interconnection area between equipment and mechanical design groups working on large digital computers.

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• • • for statistical analysis and evaluation of Reliability Data as related to electronic circuits and components.

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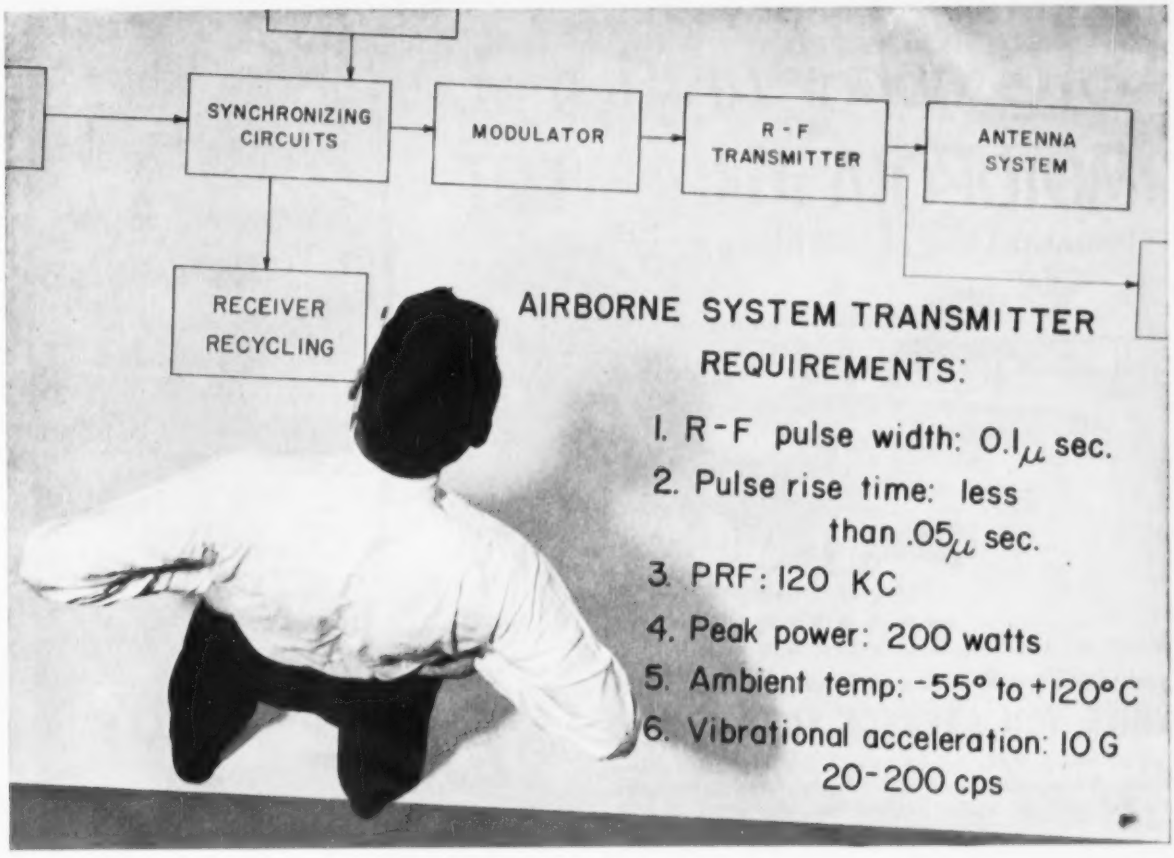
SYNCHRONIZING CIRCUITS
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RECEIVER RECYCLING
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WEAPONS: missiles, aircraft subsystems, guidance and control.
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COMMUNICATIONS: radio, digital, data links.
NAVIGATION: radio, inertial, ground-controlled.
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OPERATIONS ANALYSIS.

For an interview, write or call (NOrmandy 5-6111) Bendix Systems Division, Ann Arbor, Michigan.

Bendix Systems Division
ANN ARBOR, MICHIGAN

Bendix
AVIATION CORPORATION

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PARTS APPLICATION
(Reliability)

ME or EE degree with design experience and/or application experience. Job will be to recommend types of parts to be used and how these parts shall be used.

Qualified men will become a vital part of a Reliability Group.

GM INERTIAL GUIDANCE SYSTEM PROGRAM

• ELECTRONICS DIV.,

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To arrange personal, confidential interview in your locality send full facts about yourself today to

Mr. Cecil E. Sundeen
Supervisor of Technical Employment

AC

Electronics Div.
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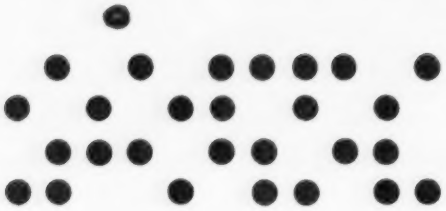

COMPUTERS

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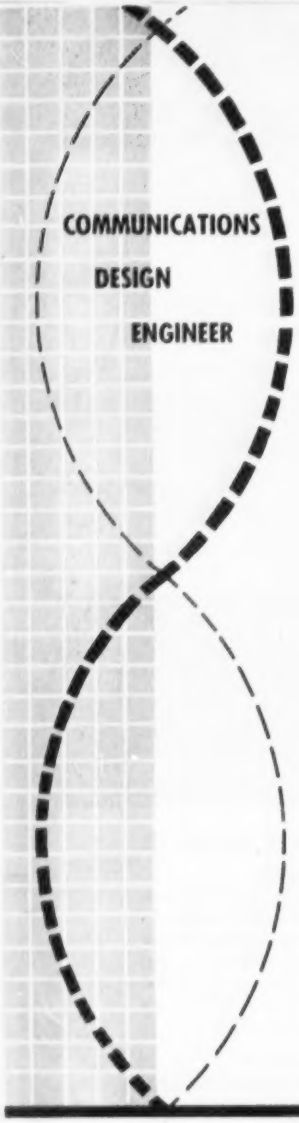

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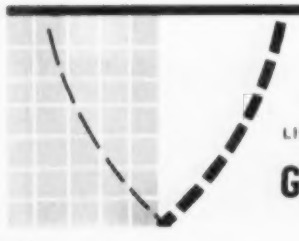

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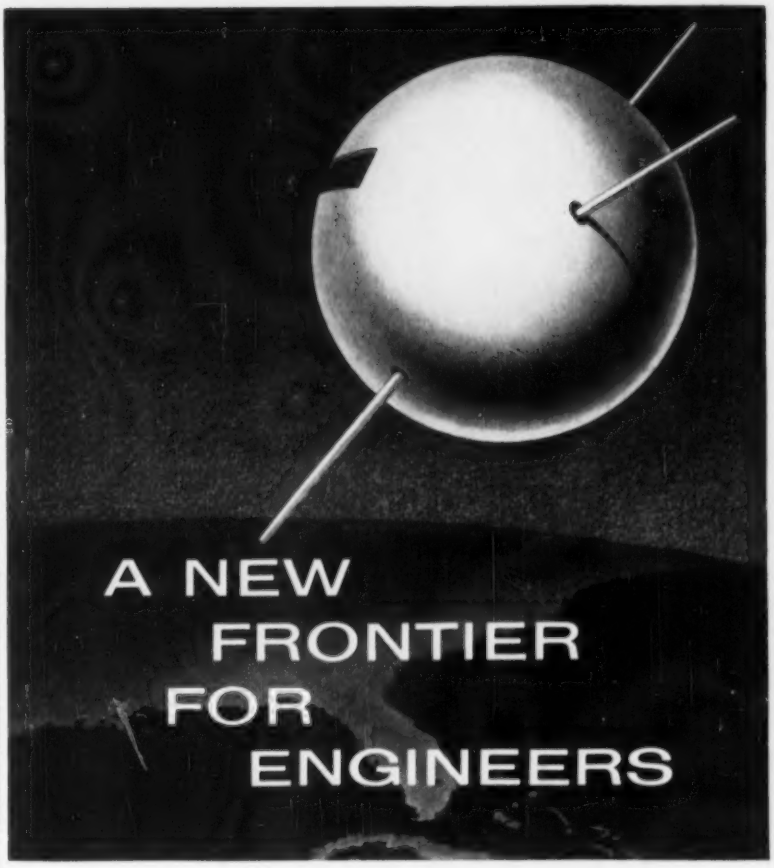

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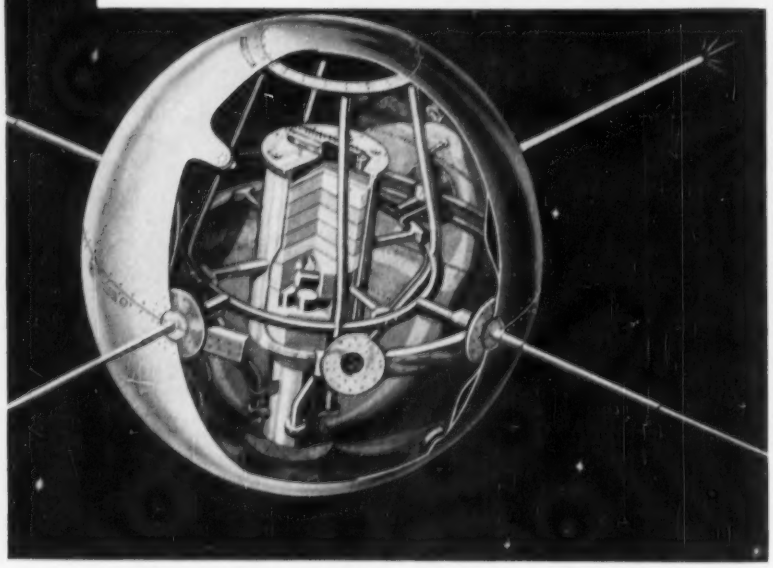

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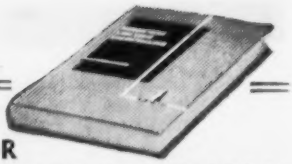

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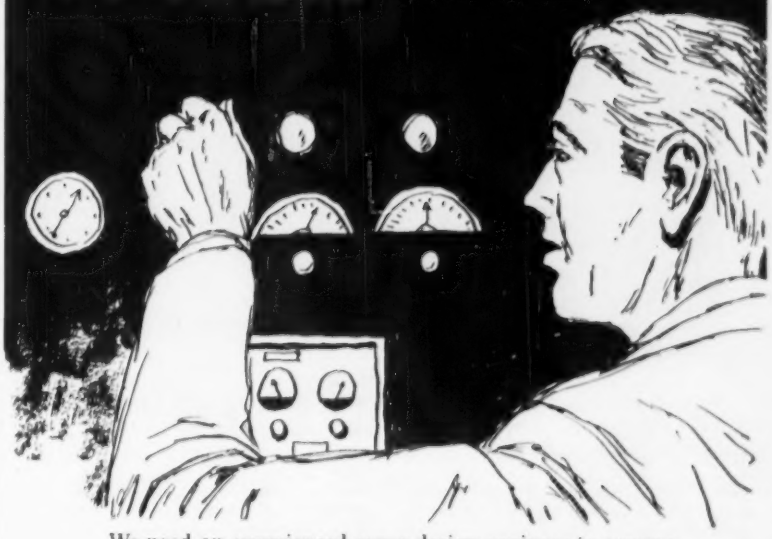

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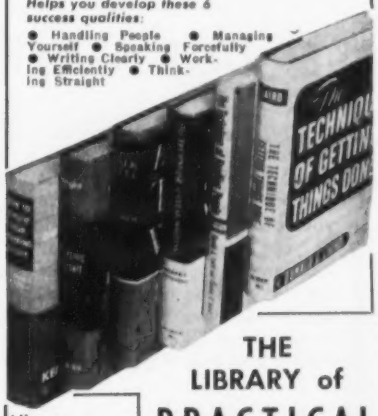

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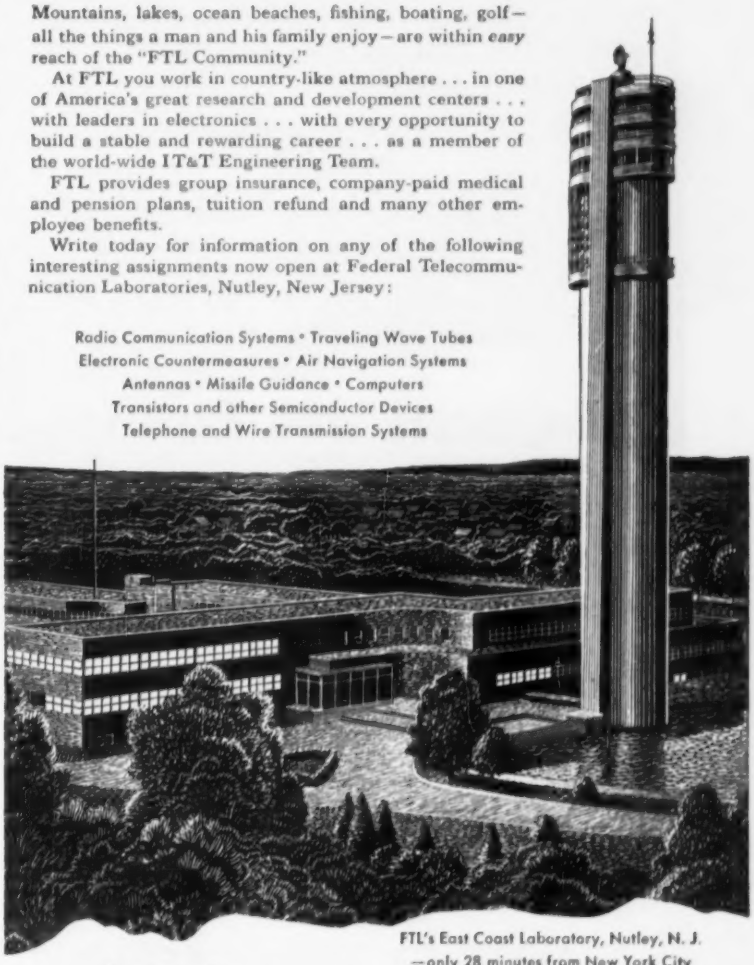

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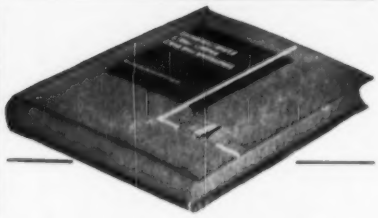

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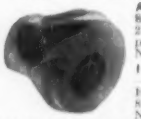

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1N34	.45	4-125A	30.25	FG-81A	3.25	403B/5591	3.25	1622	1.75
1N65	.85	4-250A	35.00	100TH (surp)	5.00	404A/5847	12.50	1626	.25
1N70	1.50	4B24/EL3C	4.50	100TL (surp)	11.69	408A	2.20	1629	.15
1P23	1.75	4C35	13.50	FG-105	11.00	412A	3.50	1635	1.60
1P37	3.50	4J21	75.00	F-123A	3.95	416B	39.00	1654	2.25
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1B32	1.00	VR1B	25.00	6SK7W	1.00	WE-305A	2.50
1B35	1.35	3AP1	1.25	6SL7W	1.25	307A/RK75	6.00
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1B40	1.00	3B24	1.00	6V6GTY	1.00	WE-310A	3.50
1B42	12.00	3B24W	4.50	6X4W	1.00	WE-311B	4.00
1B44	15.00	3B24WA	8.00	6X4WA	2.00	WE-312A	1.50
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1B62	4.00	3C24	2.00	5RC-12	150.00	WE-336A	4.50
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1N21B	1.00	3C33	6.50	12DP7	15.00	WE-338A	4.00
1N23B	.80	3C45	5.00	12GP7	15.00	WE-348A	4.50
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1N25	2.00	3DP11A	6.00	X-13	150.00	WE-350A	2.50
1N26	3.50	3D21A	3.00	BL-15	Q	350B	2.00
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1N32	9.00	3J30	25.00	PJ22	Q	WE-356B	3.50
1N33A	.60	3J31	35.00	HK24	3.00	WE-359A	1.25
1N48	4.75	3K22	150.00	26A7GT	3.00	368AS	1.00
1N42	8.00	3K23	150.00	26E6WG	2.50	385A	Q
1N46	.40	3K30	100.00	RK-26A	2.50	WE-388A	1.20
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1N61	1.40	4-125A	19.50	RK29D	Q	WE-394A	2.50
1N69	.40	4A1	2.00	VR33	30.00	WE-396A	3.25
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1P22	5.00	4B26	7.50	D-42	40.00	WE-403A	1.50
1P24	1.50	4C27	7.50	RK47	3.00	WE403B/5591	2.50
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1Q22	40.00	4E27	7.00	QK-57	Q	GL-414	65.00
1W5	.75	4J22	35.00	QK-58	20.00	WE-416B	29.50
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2B35	.80	4J32	45.00	HY-65	1.00	WE-427A	5.75
2C33	.75	4J34	25.00	RK-65/5D23	7.50	WE-428A	40.00
2C35	2.00	4J42	25.00	HY-69	2.25	GL-434A	5.00
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2C39A	10.00	4J52	50.00	RKR-73	.50	446B	1.00
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2C42	8.50	4J54	40.00	ML-188	50.00	QK459	250.00
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2C50	6.00	4X150D	25.00	WE101F	3.00	CK501AX	1.00
2C51	3.95	4X250M	35.00	FG-105	11.00	RH-587	20.00
2C52	2.75	4X500A	20.00	F-123A	2.50	QK-596/6246	150.00
2C53	9.75	5ADP1	20.00	F-128A	7.00	527	25.00
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2D29	.80	5BP2A	2.95	VT158	9.75	559	.40
2E22	2.50	5CP1	1.95	FG-166	6.75	CUE578	8.50
2E24	2.50	5CP1A	7.50	FG-172	15.00	579B	.75
2E25	1.75	5CP7	6.00	QK172	200.00	581	2.00
2E26	3.25	5CP7A	8.00	QK-181	12.50	KU-610	3.50
2E27	.60	5CP11A	9.50	HF-200	10.00	KU-627	7.50
2E32	1.00	5C22	20.00	WL-200	50.00	KU-628	7.50
2E41	1.50	5JP1	8.00	QK202	165.00	WL-652	20.00
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2J22	4.25	5JP2	5.00	204A	25.00	GL-672	20.00
2J31	12.25	5JP4	3.50	205F	6.00	WE-701A	2.50
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2J34	10.00	5JP11A	7.50	211 VT4C	.40	WE-704A	.60
2J36	20.50	5MP1	2.95	212E	15.00	WE-705A	.75
2J39	25.00	5NP1	2.00	WL-218	15.00	706AY-GY	10.00
2J48	25.00	5R4GY	1.25	CEP220	4.00	707B	2.50
2J49	35.00	5R4WGA	4.00	QK221	150.00	WE-708A	.75
2J50	35.00	5R4WGY	2.50	RX233A	.75	WE-709A	1.50
2J51	150.00	5SP1	45.00	QK-243	50.00	714A	7.50
2J52	25.00	5SP7	45.00	QK249	150.00	715A	1.75
2J56	40.00	5Y3WGT	1.40	WE245A	6.45	715B	2.50
2J61	15.00	5Y3WGTA	3.75	249B	2.50	715C	10.00
2J61A	40.00	5ZP16	60.00	249C	3.00	717A	.50
2J62	8.00	6AC7	12.00	250-R	4.50	720AY-EY	35.00
2J62A	40.00	6AC7A	.80	250TH	21.00	721A	.75
2K21	40.00	6AC7W	1.40	250-TL	12.50	721B	7.00
2K23	12.50	6AK5W	1.00	WE-251A	45.00	722A	.75
WE-252A	7.50	723A/B	7.00	2051	.65	5781WR	5.25
QK253	150.00	725A	3.00	HK1054	100.00	5784WA	7.00
WE-254A	2.50	726A	4.50	ZB1200	99.50	5785	1.50
FG-254A	75.00	726B	10.00	4210	Q	CK-5787	4.40
WE-254B	5.00	726C	15.00	R-4330	9.00	5814	.65
259A	12.50	738A	7.50	R-4340	9.00	5814WA	3.00
V260/VA6310	75.00	750TL	12.00	5516	5.50	5819	27.50
803	2.00	5517	1.00	5825	6.00		
804	7.50	5531	200.00	5829	1.00		
807	1.10	5544	15.00	5837	5000		
807W	1.75	5545	25.00	5840	3.50		
808	1.00	5551/FG271	25.00	5840A	4.50		
809	2.25	5551/FG258A	80.00	5851	4.25		
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				6101, 6J6WA	2.25		
				6106	9.00		
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				6111	4.00		
				6112	4.50		
				6116	1.25		
				6117	60.00		
				6130	6.00		
				6134	3.50		
				6136	2.50		
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				6189, 12AU7WA	3.00		
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				VA-6310/V260	75.00		
				6339	20.00		
				6486, QK428	200.00		
				6531	10.00		
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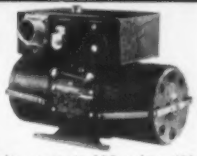

10042-1-A Bendix
DC Input 14 volts; output: 115 volts; 400 cycles, 1-phase; 50 watt **$35.00**

12116-2-A Bendix
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1217 Bendix
Output: 26 volts; 400 cycles, 6 volt amperes, 1 phase. Input: 24 VDC; 1 amp. **$15.00**

12121 Bendix
Input: 24 volt D.C. 18 amp. 12000 r.p.m. Output: 115 volts, 400 cycle, 3-phase, 250 volt amp, 7 pf. **$49.50**

12123 Bendix
Output: 115 V; 3 phase; 400 cycle; amps. .5 Input: 24 VDC; 12 amp. **$49.50**

12126-2-A Bendix
Output: 26 volts; 3 phase; 400 cycle; 10 VA; 6 PF. Input: 27.5 volts DC; 1.25 amps. **$24.50**

12130-3-B Bendix
Output: 125.5 VAC; 1.5 amps. 400 cycles single phase, 141 Va. Input: 20-30 VDC. 18-12 amps. Voltage and frequency regulated. **$49.50**

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Output 250 VA, 115 volts, 3 phase, 400 cycle, 1.25 amp., 0.8 pf. Input 27.5 volt DC, 20 amp. **$59.50**

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12147-1 Pioneer
Output: 115 VAC 400 cycles; single phase. Input: 24-30 VDC; 8 amps.
Price $39.50 each

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Output: 115 volt 400 cycle; 190 VA; single phase and 26 volt, 400 cycle, 60 VA, single phase. Input: 24 VDC. **$37.50**

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Output: 115 volts AC; 750 VA, 3 phase, 400 cycle, .90 pf and 26 volts. 50 VA single phase, 400 cycle, .40 pf. Input: 27.5 VDC 60 amps. cont. duty, 6000 rpm. Voltage and frequency regulated. **$59.50**

10339 Leland
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10486 Leland
Output: 115 VAC; 400 cycles; 3-phase; 175 VA; .80 pf. Input: 27.5 DC; 12.5 amps.; cont. duty. **$70.00**

10563 Leland
Output: 115 VAC; 400 cycle; 3-phase; 115 VA; 75 pf. Input: 28.5 VAC; 12 amps. **$35.00**

PE109 Leland
Output: 115 VAC, 400 cyc.; single phase, 1.53 amp.; 8000 rpm. Input: 13.5 VDC, 29 amp. **$50.00**

PE218 Leland
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5G Syn. Gen. 115/90VAC 60 cy.	34.50
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R210-1-A Kearfott Trans. 26/11 8V 400 cy.	20.00
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C56701 Type 11-4 Rep. 115V 60 cy.	20.00
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C76166 Volt. Rec. 115V 60 cy.	10.00
C78248 Syn. Transm. 115V 60 cy.	12.50
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2900 Transicoil 115V 400 cy.	15.00
15CX4a Synchro Transmitter MK 22 MOD 1	15.00 ea.

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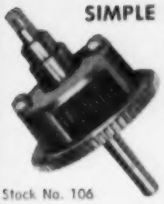
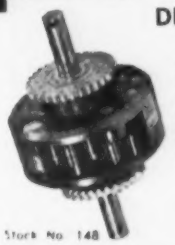


1:1 reverse ratio, 60 teeth on large gear; ¼" shaft. Size: 3" long with 1-15/16" dia.

$3.95 ea.

Stock No. 106

DIFFERENTIAL



Size 2-11/16" long 1-11/16" dia. 1-1 reverse ratio. ¼" shaft on each end; one shaft 25/32" long, one shaft 15/32" long. Input and output gear 15/16" dia. 60 teeth.

$3.50 ea.

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27 volt DC, 40 amps, intermittent duty. Input: 220 volts, 60 cycle, single phase, 9 amps. Mfgd. by Strong Electric Corp. Model #16200-B. Dimensions: 12 x 18 x 20 **Priced at $75.00**

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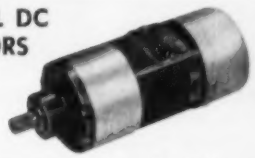

(approx. size overall 3¾" x 1¼" dia.)

5067126 Delco PM, 27 VDC, 125 RPM, Governor Controlled	$15.00 ea.
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5069230 Delco PM 27.5 VDC 145 rpm	15.00
5068750 Delco 27.5 VDC 160 rpm w. brake	6.50
5068571 Delco PM 27.5 VDC 10,000 rpm (1x1x2")	5.00
5069625 Delco 27.5 VDC 120 rpm w/governor	15.00
5069790 Delco PM, 27 VDC, 100 RPM, Governor Controlled	15.00 ea.
5BA10A118 GE 24 VDC 110 rpm	10.00
5BA10AJ37 GE 27 VDC 250 rpm reversible	10.00
5BA10AJ52 27 VDC 145 rpm reversible	12.50
5BA10AJ50, G.E., 12 VDC, 140 R.P.M.,	15.00
206-1001 PM Planetary Gear Reduced Motor with Magnetic Brake. Mfgd. by Air Equipment 26 volts 600 ma 145 rpm	17.50
5BA10FJ33, G.E., 12 VDC, 56 R.P.M., reversible	15.00
806069 Oster series reversible 1/50 h.p. 10,000 rpm 27.5 VDC 1⅝" x 3½"	5.00
C-28P-1A 27 VDC 1/100 h.p. 7,000 rpm	3.00
7100-8-PM Hansen 24 VDC 160 rpm	7.50
5SFD-6-1 Diehl PM 27.5 VDC 10,000 rpm	4.00
6-volt PM motor mfgd. by Hansen 5,000 rpm 1¼" in dia., 2" long overall	$4.00

50 MICROAMPERE WONDER RELAY

Sigma 80/30 is sealed octal plug-in rated 900 uA sensitivity but actually 420-600 uA. However if you remove the can you find that contacts are screw-in adjustable and can be screwed up for stable, dependable 50 uA sensitivity which withstands normal vibration, or for 20 uA if no vibration will be encountered. 5000 ohm coil, so voltage sensitivity is only ¼ V and power sensitivity only 12½ uW when the contacts are set for 50 uA. At 20 uA change these figures to .1 V and 2 microwatts. Large contacts rated for 2 A and 28 VDC will handle much more current at AC. This is a fast acting polarized SPDT. Direction of current through coil determines which contact will make. Contacts hold by magnetic attraction, so coil need be energized only momentarily. Reversing coil polarity pulls the moving contact away from one of the stationary contacts and over to the other. But if one of the contacts is screwed in and the other screwed out, the relay becomes a nonlatching SPDT. The moving contacts will make one of the stationary contacts only when coil current flows, and go back to the other contact as soon as current stops. Upon request with your purchase we will furnish our own tech. bulletin giving design equations for using polarized relays in Wheatstone Bridge control circuits. This relay is brand new. It cost Uncle $11.36 in lots of 100,000. **Be not muff this opportunity to steal 'em!** Industrial users write for still lower quantity prices.

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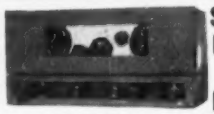
PE-206 5D2INJ3A



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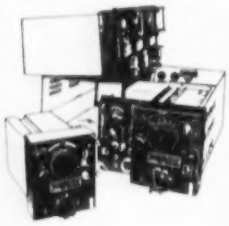

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TS-403/U AN/URM-61 1800-4,000 Mc. (Hewlett-Packard 616A)
TS-497A/URR 2-400 Mc. (Measurements Model 80)
TS-600 (XA)/U 400-1,000 Mc. (Allen D. Cardwell)
TS601 (XA)/U 975-2,000 Mc. (Allen D. Cardwell)
TS-602 (XA)/U 4,200-10,300 Mc. (Polytechnic Res. & Dev.)
Model 16C 50 Kc.—28 Mc. (Ferris)—and many, many more.

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MAG—10cm remarkable link radar, portable, operated from 6 volt battery, uses folding antenna and tripod. A pair at.....$1750.00

APS-3—3 cm—Airborne radar for search and homing. 5-in. scope. 10 brand new sets at $750.00 ea

APQ-13—Very late model airborne radar set, complete and new. One only at.....$2,950.00

SCR-545—Complete radar set, less vehicle, antenna and power plant, pretty fair condition, sold as-is at.....$1,375.00

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SCR-284—The famous mobile and ground equipment station for field use, complete with all accessories. Range 3.8—5.8 mcs; 20 watts cw, 5 watts phone.

SCR-510—Mobile, portable FM radio station. Operates from 6, 12, or 24 volt dc supply. Frequency range: 20.0 to 27.9 mcs.

SCR-610—Same as SCR-510, but with built-in speaker and range of 27.0-38.9 mcs.

SCR-528—Mobile FM radio station, operates from 12 or 24 volt dc. Frequency range: 20.0-27.9 mcs.

SCR-628—Same as SCR-528, but with range: 27.0 to 38.9 mcs.

BC-325—400 watts c.w., 100 watts new or voice operates from 110 or 220 volts ac. Freq. range: 1.5-18.0 mcs. Master oscillator or crystal control.

TCS—Collins, Navy radiotelephones for shipboard and mobile use, complete with all accessories for operation from 12, 24, 110, 230 volts d.c. and 110 or 220 volts a.c.

TBK—High frequency transmitter, 2-20 mcs; 500 watts output. Supplied complete with m/g and starter for d.c. or a.c. operation.

TBL—All wave transmitter; 350 watts output; CW and phone. Supplied complete with m/g and starter for d.c. or a.c. operation.

TAJ—Intermediate freq. transmitter, 175-550 kcs; 500 watts output. Supplied complete with m/g and starter for a.c. or d.c. operation.

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110dc to 28dc @ 250va	49.50
110/1/60 to 28dc @ 250va	97.50
220/1, 3/60 to 28dc @ 250va	97.50
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OA3/VR-75	.90	4-65A	13.50	FP-54	50.00	719A	10.00	5676	.75
OA4G	.75	4B31	20.00	HK-54	2.00	721A	.50	5678	.75
OA5	3.50	4B32	7.50	VX-55	6.00	721B	7.50	5685	10.00
OB2	.60	4C27	7.25	FG-57	9.00	723A/B	7.00	5686	1.75
OB2WA	2.75	4C33	50.00	RK-65/5D23	6.50	WE-725A	2.50	5687	2.35
OB3/VR-90	.80	4C35	15.00	FG-67	7.50	726A	4.25	5687WA	4.50
OC3/VR-105	.50	4D32	23.75	HY-69	2.00	726B	12.50	5691	4.25
OC3W	2.50	4E27	7.00	RK-73	.75	726C	10.00	5692	4.50
OD3/VR-150	.50	4J46	25.00	FG-81A	8.50	750TL	30.00	5693	3.75
OD3W	2.50	4J51	50.00	FG-95	14.00	801	3.00	5696	1.80
EL-C1A	6.00	4J52	50.00	100TH	5.00	804	7.00	5703	1.40
EAD4	.90	4J61	150.00	WE-121A	1.50	805	3.50	5703	.85
EAE4	1.00	4PR60A	30.00	WE-122A	1.50	807	1.20	5704	1.35
EAF4	2.50	4X150A	18.50	WE-123A	2.50	807W	1.25	5719	1.35
EAG5	2.00	4X500F	50.00	WE-124A	3.50	807WA	5.00	5720	15.00
EB24	5.00	5A6	2.00	VT-127A	2.00	809	2.25	5725	2.00
EB35	3.25	5AP1	5.00	FG-172	15.00	810	10.00	5736	.75
EB35A	7.50	EL-5B	4.00	FG-190	10.00	811	3.25	5727	1.25
VG-1A/3	3.50	5BP1A	7.50	CE-203	5.00	812	2.50	5728	7.50
EL-1C	1.25	5BP2A	3.00	203A	2.50	813	10.00	5734	12.00
EB83	7.50	5C22	20.00	VT-227A	2.50	814	1.25	5740	50.00
1P21	29.50	5CP1	2.00	CE-235A	5.00	815	1.25	5749	1.15
1P22	5.00	5CP1A	7.50	FG-235A	55.00	816	1.35	5758	2.25
1P28	7.50	5CP7A	8.00	WE-242C	7.50	826	.75	5751	2.00
1Y2	5.00	5CP12	10.00	QK-243	40.00	828	8.00	5755	6.50
2AC15	4.50	5FP14	5.00	WE-244A	7.50	829B	8.50	5763	1.00
2AP1	2.00	5HP1A	10.00	WE-245A	6.00	832A	4.85	5771	250.00
2AP1A	4.00	5JP1	8.50	WE-249B	3.00	836	1.25	5783WB	5.50
2AS15	4.50	5JP2A	7.50	WE-249C	2.50	837	1.25	5784	4.50
2C36	35.00	5JP4	3.50	250R	4.00	845	2.75	5787WA	6.00
2C39	5.00	5JP5A	10.00	WE-251A	42.50	850	10.00	5796	10.00
2C39A	10.00	5JP11A	7.50	WE-252A	7.50	866A	1.25	5798	15.00
2C39B	29.00	5LP1	9.50	WE-253A	2.00	866 JR	1.35	5801	5.00
2C40	6.50	5LP2A	10.00	WE-254A	2.25	868/PJ-23	1.50	5803	5.00
2C40A	26.00	5R4GY	1.25	WE-257A	10.00	872A	1.00	5814	.75
2C42	8.00	5R4WGY	2.50	FG-258A	75.00	874	.75	5814A	.75
2C43	8.00	5RP1A	17.50	WE-259A	10.00	884	.95	5814WA	3.00
2C44	.25	5RP11A	75.00	WE-262B	5.00	885	.65	5819	25.00
2C46	6.00	5SP1	50.00	FP-265	18.50	913	17.50	5827	4.00
2C50	6.00	5SP7	40.00	WE-267B	4.00	917	1.40	5828	6.00
2C51	3.25	5UP7	12.50	WE-268A	5.00	918	1.50	5829	.85
2C52	2.75	5X3	2.00	WE-271A	5.00	920	2.00	5830	85.00
2C53	10.00	5XP1	50.00	WE-272A	7.00	922	1.50	5836	93.00
2D21	.70	5XP11	50.00	WE-274B	.75	923	1.25	5840	3.00
3D21W	.80	EL-C6J	10.00	WE-275A	3.50	931A	4.00	5847	12.00
2E22	2.00	EL-C6L	6.50	WE-276A	10.00	959	1.15	5847	12.00
2E24	2.00	6AC7W	.75	WE-279A	175.00	CK-1006	2.25	5854	1.00
2E26	3.25	WE-6AK5	1.25	WE-282A	2.00	1237	5.50	5876	5.00
2J51	150.00	6AK5W	1.00	WE-282B	4.00	HY-1269	3.25	5881	3.00
2J52	50.00	6AL5W	.75	WE-283A	3.25	1274	2.50	5886	2.75
2J54	25.00	6AN5	2.25	WE-285A	4.50	1611	1.00	5899	3.50
2J59	50.00	6AQ5W	1.70	WE-286A	3.25	1613	1.00	5907	4.00
2J61	12.50	6AR6	1.35	WE-287A	2.00	1614	1.50	5915	.50
2J62	4.00	6AR6WA	2.50	WE-293A	8.00	1619	.50	5932	3.25
2J64	75.00	6AS6	1.25	WE-300B	5.00	1620	3.75	5933	1.35
2K25	12.50	6AS6W	2.00	304TH	12.50	1624	1.25	5933WA	5.00
2K26	32.50	6AS7G	2.50	304TL	12.50	1625	.50	5948/1754	150.00
2K28	30.00	6AU6WA	2.25	WE-310A	3.50	1846	50.00	5962	4.00
2K29	30.00	6BA6W	1.25	WE-311A	3.50	2050	1.00	5963	1.25
2K30	50.00	6BE6W	2.50	WE-316A	.50	2050W	3.00	5964	1.00
2K33A	58.75	6BL6	30.00	WE-323A	7.50	ZB-3200	75.00	5975	3.00
2K34	100.00	6BM6	30.00	WE-323B	5.00	5528	6.50	5977	2.50
2K35	100.00	6C4W	4.00	VT-327A	3.50	5550	30.00	5979	7.50
2K39	100.00	6C21	14.00	WE-328A	3.50	5552	55.00	5980	6.50
2K41	85.00	6F4	2.25	WE-336A	3.50	5553	75.00	5981/5650	50.00
2K45	30.00	6J4	1.25	WE-338A	3.50	5556	10.00	5998	4.75
2K47	100.00	6J4WA	2.00	WE-339A	9.50	5557	4.00	6005	1.70
2K48	50.00	6J6W	.85	WE-347A	2.50	5558	5.00	6021	3.75
2K50	125.00	6K4	2.00	WE-348A	4.50	5559	9.00	6021A	4.50
2V3G	1.25	6K4A	2.50	WE-350A	2.50	5560	14.00	6028	2.00
2X2A	.75	6L4	3.50	WE-350B	2.00	5584	3.00	6037	50.00
3ABP1	50.00	6L6WGA	3.25	WE-352A	15.00	5591	2.75	6038	7.50
3AF1	2.00	6L6WGB	3.50	WE-354A	8.50	5610	1.00	6073	1.50
3AP11A	5.00	6Q5G	2.25	WE-355A	8.50	5633	5.00	6080	4.00
3B24	.75	6SJ7WGT	2.00	WE-388A	1.25	5634	5.00	6087	4.25
3B24W	4.50	6SK7W	.85	WE-393A	3.50	5635	5.00	6098	2.50
3B24WA	7.50	6SK7WA	2.00	394A	2.50	5636	2.50	6100	2.00
3B25	3.50	6SL7WGT	1.25	WE-396A	3.25	5636A	3.00	6130	5.00
3B26	2.75	6SN7WGT	1.00	WE-403A	1.35	5637	3.50	6134	3.50
3B28	4.00	6SU7GTY	2.00	WE-403B	2.75	5638	3.00	6136	2.25
3B29	5.50	6X4WA	2.50	WE-404A	12.00	5639	5.00	6137	2.00
3BP1	2.00	6X5WGT	1.25	WE-407A	2.50	5639A	6.00	6146	4.40
EL-3C	4.00	7F8W	1.50	WE-408A	2.00	5640	5.00	6189	3.00
EL-C3JA	12.50	7MP7	15.00	WE-409A	4.25	5641	4.50	6201	3.00
3C23	3.25	VX-10	4.00	WE-417A	12.00	5642	.90	6236	185.00
3C24	2.50	12AT7WA	3.00	WE-418A	15.00	5643	4.00	6263	10.00
3C33	6.00	12AU7WA	3.00	WE-420A	6.50	5644	5.75	6264	10.00
3C45	5.00	12DP7A	25.00	WE-421A	4.75	5645	5.00	6322	8.50
3D22	9.50	15E	1.25	WE-429A	8.00	5646	3.75	6328	4.85
3E22	4.00	FG-17	4.00	446A	.50	5647	4.00	6655	35.00
3E29	10.00	HK-24	2.00	446B	1.00	5650	50.00	8991	4.50
3GP1	2.00	HK-24G	2.50	450TH	38.50	5651	1.25	8012A	3.50
3J21	50.00	26Z5W	3.00	450TL	38.50	5651WA	3.00	8013A	4.50
3J31	35.00	FG-27A	15.00	464A	1.75	5654	1.25	8020	1.00
3JP1	7.50	FG-32	5.00	GL-502A	1.25	5656	4.00	9001	.75
3JP7	10.00	FG-33	15.00	GL-575A	10.00	5663	.95	9002	.50
3JP12	10.00	VX-33A	5.00	631-P1	5.00	5667	100.00	9003	1.00
3K27	150.00	35T	2.75	WE-701A	1.50	5670	2.00	9005	2.00

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C1J	4.35	OA2	.76	2K25	16.50	5BP1A	8.95	9LP7	5.00	7868	14.95	724B	1.45	872A	1.79	5703	1.19
C1R	4.35	OB2	.76	2K26	18.95	5CP1	2.99	10Y	1.49	7868A	1.49	725A	3.99	874	1.79	5725	1.99
C6J	7.99	1B22	1.49	2K28	29.50	5C22	25.00	12K5	1.65	394A	2.99	726A	5.50	878	.98	5726	1.00
CK-551AX/ 2B41	1.79	1B24	5.99	2K33A	59.95	5CP1	3.99	24W	1.49	WL-417A	2.74	726B	25.00	884	1.00	5744	.79
CRP RK- 72	.49	1B25	9.95	2K41	72.50	5CP1A	12.49	35T	4.99	GL-434A	6.65	726C	24.50	885	1.00	5749	1.25
EC1	1.95	1P10	2.99	2K45	12.50	5CP7	9.99	35TG	7.25	446A	1.15	726AY/BY/ CY/DY/ FY/GY	18.00	9-D	1.00	5751	2.15
EF-50	.88	2A4/G	3.50	2K54	18.95	5CP11A	14.99	51A	2.29	446B	1.79	9PP1	2.99	9002	2.99	5768	2.95
EI148	.25	2AP1	3.99	2K55	19.50	5DP1	6.99	QK-62	24.50	WL-460	8.99	918	1.99	9003	1.99	5763	1.29
EM-1GA	39.50	2BP1	7.95	2P1	3.99	5FP7	3.99	RK65	7.95	WL-464A	4.25	730A	7.95	9227	1.45	5814	1.35
F123A	5.99	2C21	.49	2P1/G	3.39	5HP4	2.49	/5D23	14.95	800	1.29	931A	2.99	9406	1.49	5851	3.20
FG17	4.50	2C22	.49	2X2	.38	5JP1	16.99	45Y	.38	471A	1.25	954	.38	9412	.98	5879	1.15
FG-105	14.99	2C26	.49	2X2/A	.38	5JP2	14.99	100TH	16.95	CK-608AX	1.10	955	.29	9413	1.49	6031	2.99
FG-154	14.99	2C26A	.49	3A5	.69	5JP7	15.00	203A	8.99	CK-621AX	1.10	956	.29	9416	1.49	6063	1.19
FG172	24.95	2C33	.69	3AP1	5.95	5LP1	7.99	203B	9.99	027	14.50	957	.25	9417	.98	6064	.74
HF-100	7.49	2C39	4.99	3AP1A	4.95	5NP1	13.95	205B	5.00	803	9.00	958	.25	9420	1.49	6072	1.89
HK-24	9.75	2C39A	11.50	3B24	2.99	5RP1	6.99	205D	5.00	WL-530	19.50	958A	.25	9422	1.49	6077	1.25
HK-54	1.09	2C40	8.95	3B24W	4.99	5RW4GY	7.99	211	49.50	WL-531	6.25	959	1.49	9427	.98	6080	2.99
HK-257	2.49	2C43	10.99	3B25	3.49	5TP1	3.49	211A	.72	807	1.29	991	.39	9428	1.49	6080W	3.90
HR-231A	.69	2C46	7.49	3B28	3.49	6AC7	.69	211A	3.25	807W	1.79	1000	1.79	CK1005	.46	6136	1.95
HY-65	1.70	2C51	2.75	3C21	1.29	6AS6	1.39	286TH	24.95	808	1.79	1613	.49	CK1006	1.97	6082W	16.50
HY-69	1.98	2C52	5.50	3C22	64.95	6AS7/G	2.49	286TL	13.95	809	1.95	1616	.49	1626Y	94.50	8005	4.50
HY-114B	1.35	2C53	2.45	3C23	5.95	6BM6	19.50	286R	4.99	810	3.10	1619	.49	1629	2.95	8012	1.25
HY-115	1.35	2C54	.49	3C24	1.50	6C4	.65	203A	5.00	811	1.95	1620	.49	5517	.49	8013	2.50
HY-130	3.20	2C55	.49	3C28	5.95	6D4	2.99	259A	5.99	811A	2.49	1621	.49	5518	.49	8013A	3.49
KU-610	2.49	2C56	.49	3C33	8.99	6F4	2.99	264C	5.00	812A	11.50	1622	.49	5520	.49	8020	2.9
RK-60	1.99	2D21	.79	3C45	6.25	6J4W	3.95	271A	12.99	813	21.50	1623	.49	5521	.49	8025A	2.25
RK-61	3.50	2D21W	1.19	3D22	3.49	6J6W	1.29	274A	5.95	814	3.95	1624	.49	5522	.49		
RK-65/5D23	14.99	2J21	7.99	3D23	2.75	6K4W	3.99	274B	1.79	815	1.99	1625	.49	5523	.49		
RK-72	6.50	2J21A	6.95	3DP1	1.88	6K6GT	1.49	274C	2.25	816	1.05	1626	.29	5524	.49		
RX-231A	.69	2J22	4.95	3D23	2.50	6K7	3.99	274N	2.25	826	.75	1625	.29	5525	.49		
VT25/10	.49	2J25	2.50	3DP1	1.88	6K8G	1.49	276A	2.25	829B	9.95	1629	.25	5526	.49		
VT25A/10Y	.59	2J26	5.95	3E29	10.25	6K8W	3.49	282A	6.49	829C	3.50	1630	.49	5527	.49		
VT67/10Spec	.26	2J30	9.95	3EP1	1.88	6L6	1.49	282B	6.49	830B	2.99	1631	.49	5528	.49		
VT-158	17.50	2J31	14.50	3FP1	2.95	6L6G	1.49	282C	6.49	832	1.99	1632	.49	5529	.49		
VU-111	.17	2J32	14.50	3GP1	1.95	6L6GA	1.49	283	7.25	832A	7.49	1633	.49	5530	.49		
1B32/532A	.99	2J33	11.50	3HP1	2.95	6L6GB	1.49	284C	6.49	833A	31.50	1634	.49	5531	.49		
QK-59	29.50	2J34	11.50	3J21	49.94	6L6GC	1.49	286A	7.25	834	2.45	1635	.49	5532	.49		
QK-61	32.00	2J35	11.00	4A11	.49	6N7GT	.79	304TH	7.95	836	1.99	1636	.49	5533	.49		
QK-185	99.00	2J36	11.50	4B36	4.49	6P4	2.99	304TL	13.95	837	1.99	1637	.49	5534	.49		
VR-78	.85	2J41	16.40	4C27	8.95	6P5GT	1.49	307A	1.85	838	3.50	1638	.49	5535	.49		
VR-90	.85	2J42	48.27	4C35	9.95	6Q7	.89	310A	3.99	841	.59	2050W	2.49	5536	.49		
VR-105	.79	2J62	9.60	5AP1	3.95	6R7	.89	313A	3.99	842	1.99	2051	.76	5537	.49		
						6SA7	1.49	323A	4.49	843	6.49	5591	2.95	5539	.49		
						6SA7/G	2.49	350A	7.99	845	19.00	5636	2.75	5540	.49		
						6SH6	19.50	350B	8.99	849	3.10	5651	1.39	5541	.49		
						6SJ7	.89	700A	1.79	860	.69	5654	1.49	5542	.49		
						6SK7	.89	700B	2.49	864	.69	5656	5.25	5543	.49		
						6SL7	1.49	700C	3.75	865	.49	5670	2.20	5544	.49		
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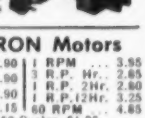

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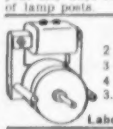

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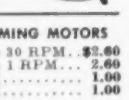

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VT-158	9.50	337A	4.75
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829	3.50	4X150G	28.50
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833	.70		
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852	4.00	508	190.00
864	.25	838	140.00
1611	1.00	880	200.00
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6AC7W	1.00	6J6WA	1.50
6AK5W	1.20	6K7W	.90
6AL5W	.70	6SN7WGT	1.50
6AS6		6X4W	1.35
6BF7W	2.40	7F8W	1.75
6C4W	3.75	12AT7WA	1.00
		12SK7	1.25
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1G4GT/G	6F6	6SK7	7A8
2A3	6J4	6SK7GT	7C7
6AB7	6J5	6SK7GTY	7F8
6AC7	6K8GT	6SK7Y	12A6
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C5B	.75	3050	1.00
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5C22	25.00	2051	.65
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FG-32	4.00	5560, FG95	16.00
FG105	11.00	5948, 1754	255.00
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VT-158	9.00	6130	4.00
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2J22	4.50	4J34	35.00
2J26	4.50	4J50	90.00
2J27	4.50	4J51	75.00
2J31	32.50	4J52	90.00
2J32	9.50	4J61	145.00
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2J34	13.00	5J23	75.00
2J37	28.50	QK60	19.50
2J38	28.50	QK62	19.50
2J45	32.50	QK284	90.00
2J50	32.50	706AY-GY	14.00
2J55	45.00	706CY	15.00
2J56	45.00	714A	9.50
2J61	9.95	714AY	50.00
2J62	5.50	725A	2.75
4J21	100.00	5586	105.00
4J31	125.00	5657	105.00
4J42	25.00	5780	175.00
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5588	75.00	5719A	2.75	5977A	3.00
5610	1.00	5722	3.25	5985	9.75
5611	5.75	5725	2.00	5992	12.00
5635	6.00	5726	.70	5993	9.00
5636	2.85	5726-6057		5995	4.60
5637	1.75	6AL5W	1.00	6005	1.75
5639	5.75	5744	1.00	6075	3.85
5640	5.85	5744WA	5.50	6045	2.95
5641	4.75	5749	1.20	6073	1.50
5642	1.00	5750	2.25	6080	4.75
5643	4.50	5751	2.00	6082WA	6.50
5644	6.25	5751WA	3.50	6087	4.00
5645	5.75	5763	1.10	6096	1.10
5646	4.50	5781	4.25	6098CT	1.90
5647	4.50	5784	4.75	6099	1.40
5651	1.40	5784WA	7.00	6100	2.00
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5654	1.00	5787WA	5.50	6106	8.50
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5654/6AL5W		5814	.50	6111	3.95
6096	2.95	5814A	1.50	6112	4.50
5658	6.75	5814WA	3.00	6147	3.00
5663	1.20	5829	1.00	6152	6.00
5670	1.00	5829WA	6.50	6159	1.00
5670WA	4.25	5840	3.50	6161	45.00
5672	1.25	5840A	4.75	6201	
5677	5.00	5844	1.40	12AT7WA	3.50
5678	1.00	5845	5.00	6211	1.50
5686	1.70	5851	3.50	6263	11.50
5687	2.40	5854	1.10	6279, SC22	27.00
5687WA	4.75	5876	7.00	6280, 4158	35.00
5691	4.75	5896	3.00	6386	5.00
5692	5.00	5898	7.50	7193	.20
5693	4.25	5899	4.00	8012	1.00
5696	1.00	5899A	5.75	8020A	1.75
5702	1.50	5902	4.00	9001	.75
5702WA	5.85	5911, SU4WG	4.75	9002	.50
5703WA	4.00	5932	3.50	9003	1.00
5704	1.50	5933	1.50	9004	.75
5718	1.75	5967	10.00	9005	2.25
5718A	4.00	5969	10.00	9006	.20

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OD3	.55	5X3	2.20	815A RCA	11.50
5B	2.00	6-4	1.00	575A	12.50
5C	1.95	6-7	1.00	705A	.65
1V	.90	6-11	1.00	816	1.40
2C53	12.50	7H4B	1.00	836	1.20
2X2	.25	15R	.30	866A	1.20
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3B24	1.35	18RR, 8870	1.75	872A	1.15
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2K28	24.00	6BM6A	32.50	5721	135.00
2K43	100.00	VES	P.O.R.	5961/5858	60.00
2K45	32.50	V50	80.00	6119	90.00
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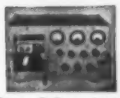
AN/APR-4

38-4000 MC RECEIVER

RDO

NAVY SEARCH RECEIVER



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SHORAN

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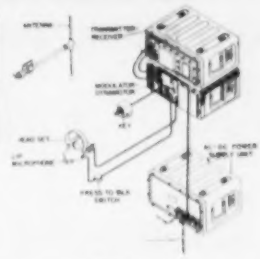

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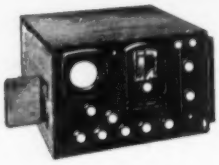

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These units are mounted in FT243 holders, and are designed to operate at the 9th overtone. Thus the output of a 16 mc crystal would be 145 mc. Fundamental frequencies are as follows: (in mcs/sec)

15.073	15.753	17.173	17.413
15.113	15.793	17.193	17.453
15.153	15.873	17.253	17.493
15.233	15.953	17.113	17.533
15.313	15.293	17.293	17.573
15.353	16.953	17.333	17.773
15.393	16.973	17.373	17.993
15.473	16.993		18.133
15.633	17.013		
15.713	17.053		

Price - - - $1.50 ea.

3000 MC WAVEMETER

Mfd. by GE for Armed Services. Calibrated directly in mcs/sec. from 2200 to 4800 mc. Comes furnished with variable attenuator, coax. adaptor cord, and pickup antenna. Has output jack for external meter or other monitor device. Resonance indicator is 3½ 20 microamp meter. Brand new, in portable wooden carrying case..... $75.00

10 CM R.F. HEAD

Complete R.F. Head and Modulator delivers 50 KW Peak R.F. at 3000 MC. Pulser delivers 12KV pulse at 12 Amp. to magnetron of .5, 1, or 2 microsec. duration at duty cycle of .001. Unit requires 115V, 400-2400 Cycles, 1 phase @ 8.5A. Also 24 28 VDC @ 2A. External sync. Pulse of 120 V Req'd. Brand new. Complete with magnetron, magnet, plumbing and all tubes $275

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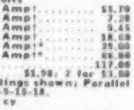

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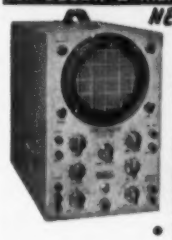

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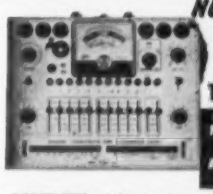

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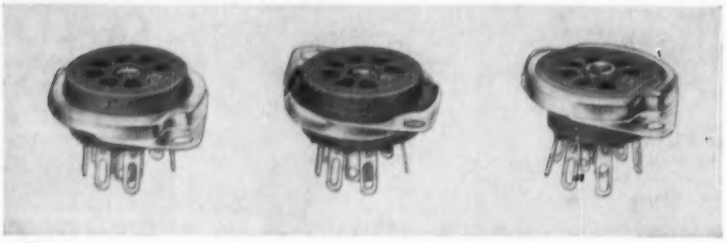

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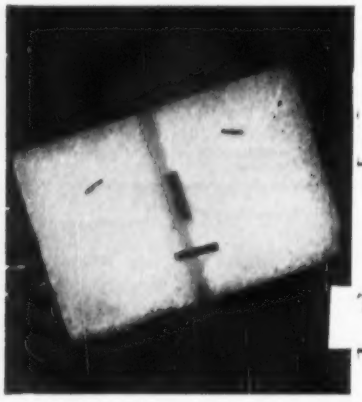

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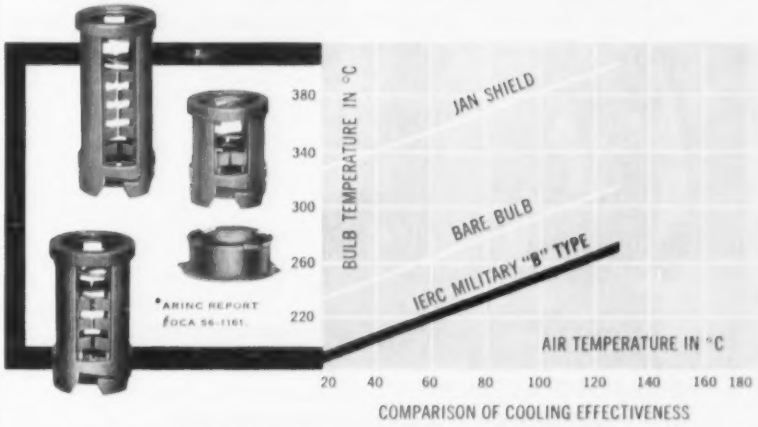

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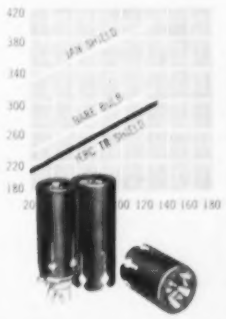

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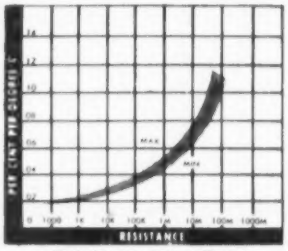
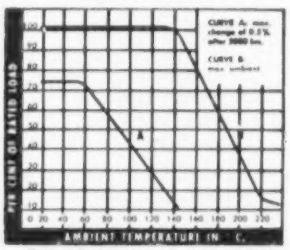


Typical temperature coefficient characteristics for Allies' Products carbon deposit resistors.

VALUES and SIZES

RESISTOR	WATTS	OHMS
APT-5	5	50 ohms to 5 meg. ±1%
APT-2	2	20 ohms to 20 meg. ±1%
APLT-1	1	50 ohms to 100 meg. ±1%
APT-1	1	5 ohms to 10 meg. ±1%
APCT-1*	1	10 ohms to 10 meg. ±1%
APHT-0.5	½	10 ohms to 20 meg. ±1%
APZT-1/10	1/10	10 ohms to 100 K. ±1%
APST-½**	½	1 ohm to 10 meg. ±1%
APXT-½*	½	5 ohms to 2 meg. ±1%
APYT-¼	¼	5 ohms to 1 meg. ±1%

*Distributor Stock, RMA Values
**Sales Office & Distributor stock, RMA values.



Typical derating curve for 1 watt Allies' Products carbon deposit resistors

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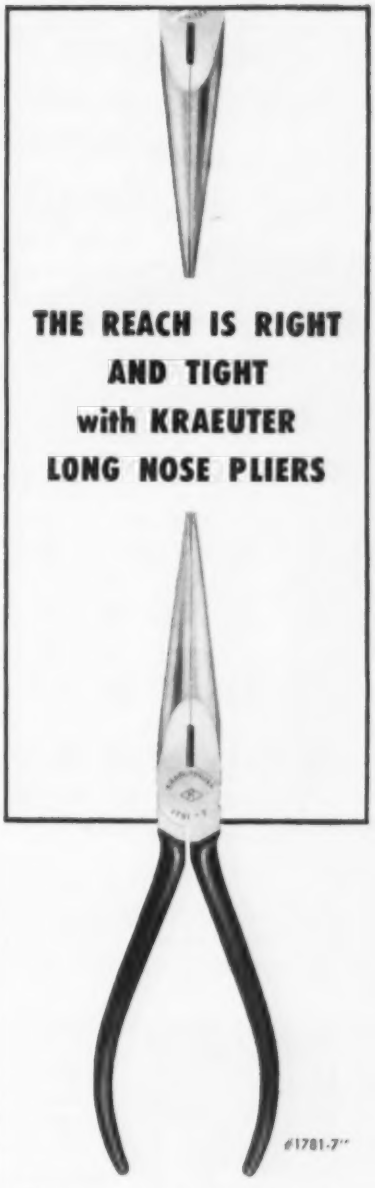

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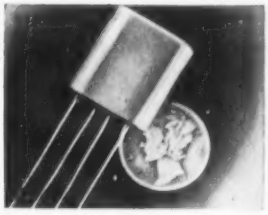
SEALED AND POTTED
Subminiature



- Amplifiers, flip-flops, sawtooth generators, multivibrator, oscillators
- Units may be used as plug-in elements or wired directly into circuits
- Operating temperature: −25°C to +50°C
- Operation underwater
- Truly subminiature — less than one-fifth of a cubic inch

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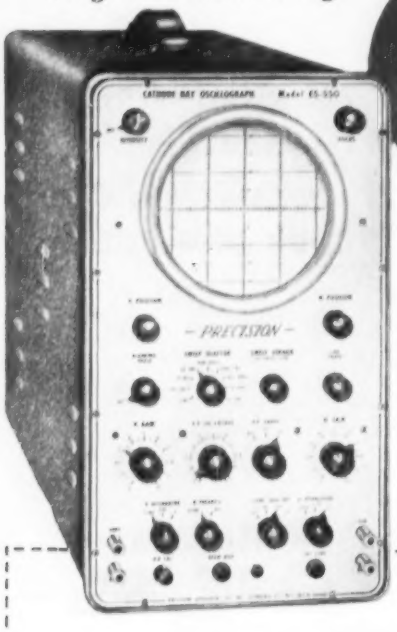

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ES-550
5" OSCILLOSCOPE
'The Scope for Color TV'

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17	38	59	77	96A	118	195	219	243	267	288	310	334	356T	369B	384L	394M	455LB
19	39	60	78	96B	119	197	220	244	268	289	311	335	356B	370	384RT	394B	456R
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23	42	62	80	98	124	200	222	246	270	291	313	337	356R	372	385LT	396M	2nd Cover
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L2	L7	L12	L17	L22	L27	L32	L37	L42	L47	L52	L57	L62	L67	L72	L76	L82	L87	L92	L79
L3	L8	L13	L18	L23	L28	L33	L38	L43	L48	L53	L58	L63	L68	L73	L78	L83	L88	L93	L98
L4	L9	L14	L19	L24	L29	L34	L39	L44	L49	L54	L59	L64	L69	L74	L79	L84	L89	L94	L99
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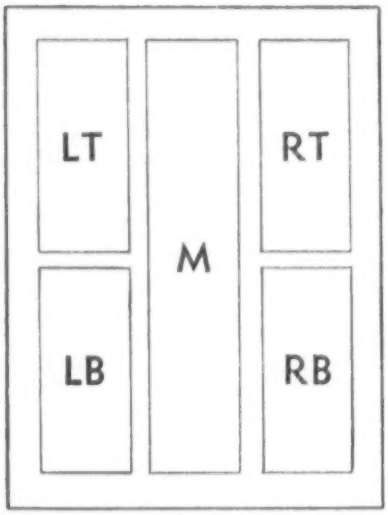

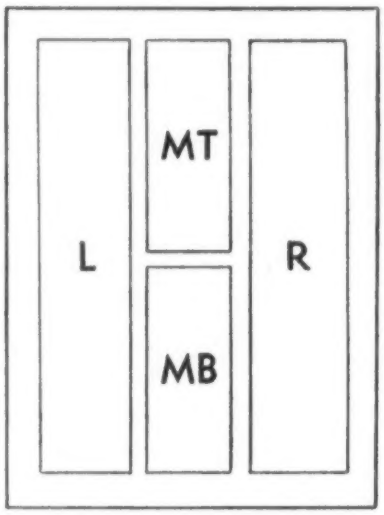

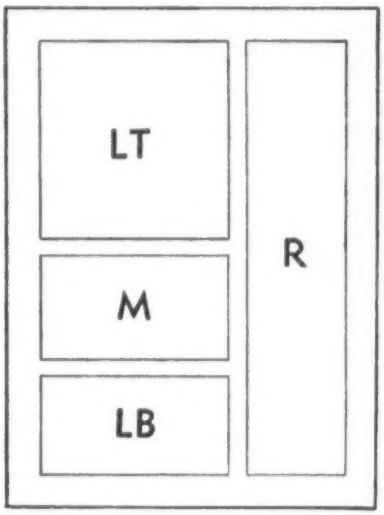

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USE THIS KEY:

R—Right

RT—Right Top

RB—Right Bottom

L—Left

LT—Left Top

LB—Left Bottom

M—Middle

MT—Middle Top

MB—Middle Bottom

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MAY 1 · 57
CARD EXPIRES AUG • 1ST

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11	35	56	74	94	115	140	216	239	264	285	306	331	353L	367	381B	392RT	484T
13	36	57	75	95	116	191	217	240	265	286	307	332	353R	368	382	392RB	484B
15	37	58	76	96	117	193	218	241	266	287	308	333	354T	369T	383T	394T	486LT
17	38	59	77	96A	118	195	219	243	267	288	310	334	355T	369B	384L	394M	485LB
19	39	60	78	96B	119	197	220	244	268	289	311	335	355B	370	384RT	394B	485R
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32B	51	69	89	110	131	210	234	257	280	300	324	348	361T	378T	389L	450B	
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NEW PRODUCT INFORMATION? USE SECTION B

SECTION B — CIRCLE FOR NEW PRODUCTS HERE!

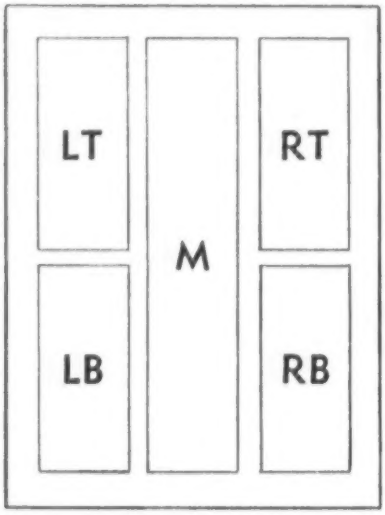
P1	P6	P11	P16	P21	P26	P31	P36	P41	P46	P51	P56	P61	P66	P71	P76	P81	P86	P91	P96
P2	P7	P12	P17	P22	P27	P32	P37	P42	P47	P52	P57	P62	P67	P72	P77	P82	P87	P92	P97
P3	P8	P13	P18	P23	P28	P33	P38	P43	P48	P53	P58	P63	P68	P73	P78	P83	P88	P93	P98
P4	P9	P14	P19	P24	P29	P34	P39	P44	P49	P54	P59	P64	P69	P74	P79	P84	P89	P94	P99
P5	P10	P15	P20	P25	P30	P35	P40	P45	P50	P55	P60	P65	P70	P75	P80	P85	P90	P95	P100

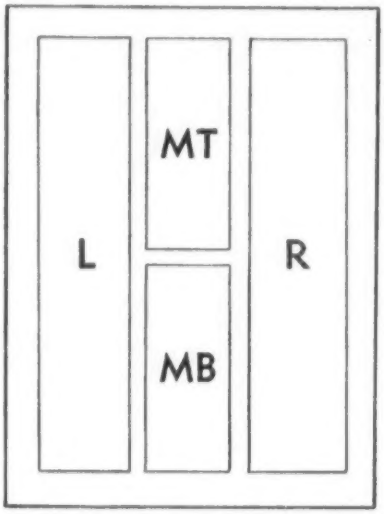
LITERATURE? USE SECTION C

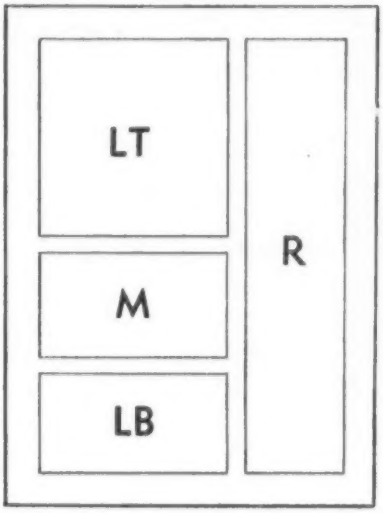
SECTION C — CIRCLE FOR LITERATURE HERE!

L1	L6	L11	L16	L21	L26	L31	L36	L41	L46	L51	L56	L61	L66	L71	L76	L81	L86	L91	L96
L2	L7	L12	L17	L22	L27	L32	L37	L42	L47	L52	L57	L62	L67	L72	L76	L82	L87	L92	L97
L3	L8	L13	L18	L23	L28	L33	L38	L43	L48	L53	L58	L63	L68	L73	L78	L83	L88	L93	L98
L4	L9	L14	L19	L24	L29	L34	L39	L44	L49	L54	L59	L64	L69	L74	L79	L84	L89	L94	L99
L5	L10	L15	L20	L25	L30	L35	L40	L45	L50	L55	L60	L65	L70	L75	L80	L85	L90	L95	L100

DIAGRAMS BELOW SHOW HOW TO USE THE KEY
ON PAGES WITH MORE THAN ONE ADVERTISEMENT







NOTE: additional postage MUST be added for mailings from FOREIGN COUNTRIES

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PERMIT NO. 64
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BUSINESS REPLY CARD
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You must circle the page number with the correct letters after it (i.e. 240 L, which means page 240 Left).

USE THIS KEY:

R—Right

RT—Right Top

RB—Right Bottom

L—Left

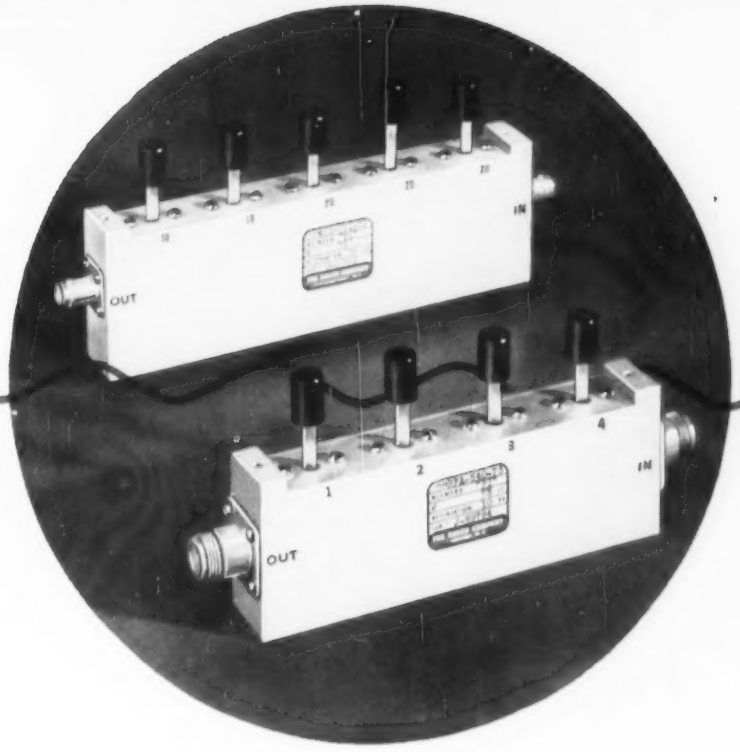
LT—Left Top

LB—Left Bottom

M—Middle

MT—Middle Top

MB—Middle Bottom



FOR ACCURATE ATTENUATION OVER A WIDE FREQUENCY RANGE...

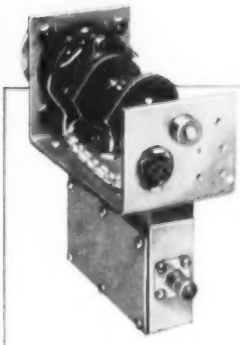
RF Attenuators by DAVEN

These units are used in signal generators, wide-band amplifiers, pulse generators, field intensity meters, micro-wave relay systems, and repeater stations. They find application as laboratory standards, test equipment, and for checking out all types of instruments.

Daven RF Attenuators are available, in combination, with losses up to 120 Db in two Db steps; or 100 Db in one Db steps. Due to their internal circuitry and construction, they have a **zero insertion loss** over the **frequency range from DC to 225 megacycles.**

Standard impedances are 50 and 73 ohms, with special impedances available on request. Resistor accuracy is within ±2% at DC. An unbalanced circuit is used which provides constant input and output impedance. The units are supplied with either UG-58/U or UG-185/U receptacles or Coaxial lead terminations. Individual units with single-section cavities can be obtained.

Many of these types are available for delivery from stock.



Solenoid actuated RF Attenuators are also available in various decibel combinations and any number of steps up to 5.

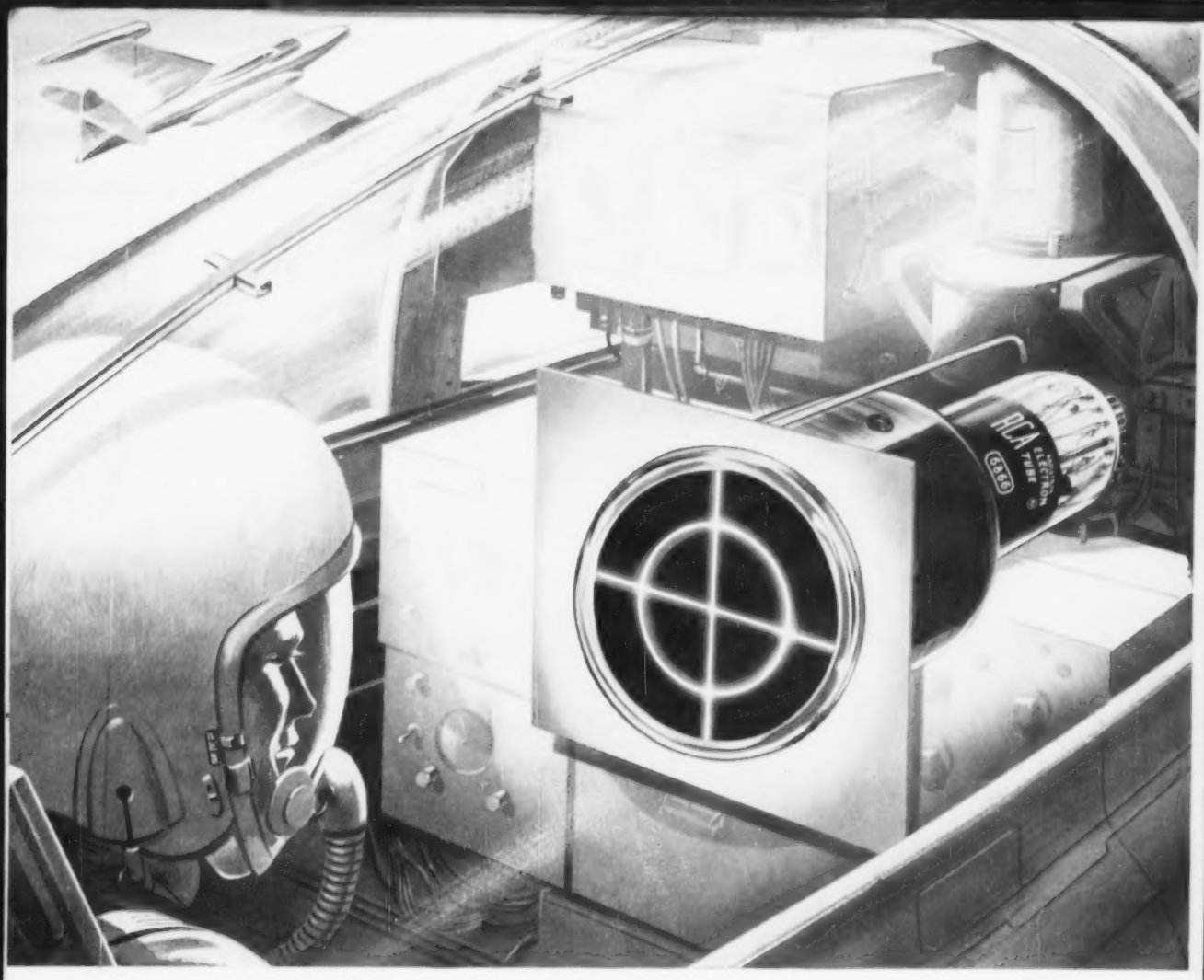
TYPE	LOSS	TOTAL Db	STANDARD IMPEDANCES
RFA & RFB 540	1, 2, 3, 4 Db	10	50/50Ω and 73/73Ω
RFA & RFB 541	10, 20, 20, 20 Db	70	50/50Ω and 73/73Ω
RFA & RFB 542	2, 4, 6, 8 Db	20	50/50Ω and 73/73Ω
RFA & RFB 543	20, 20, 20, 20 Db	80	50/50Ω and 73/73Ω
RFA & RFB 550	1, 2, 3, 4, 10 Db	20	50/50Ω and 73/73Ω
RFA & RFB 551	10, 10, 20, 20, 20 Db	80	50/50Ω and 73/73Ω
RFA & RFB 552	2, 4, 6, 8, 20 Db	40	50/50Ω and 73/73Ω

Other Db loss combinations are available.

Write for complete information

THE DAVEN CO.
526 West Mt. Pleasant Ave.
Route 10, Livingston, N. J.

WORLD'S LARGEST MANUFACTURER OF ATTENUATORS



He "reads" his radar data...

IN BRIGHT DAYLIGHT

No hood needed for this presentation, because the RCA-6866 Display Storage Tube pictured here produces an average display brightness of 2750 foot-lamberts—brilliant enough to view directly in bright daylight!

In addition to its application in military electronics, RCA-6866 offers many exclusive features of special interest to equipment designers in the field of electronic data processing. For example, RCA-6866 can present non-flickering display of electronic information—for as long as 60 seconds after writing stops. It can "write" at speeds as high as 300,000 inches per second—fast enough to "freeze" microsecond transients for visual or photographic examination.

Are you working with airplane-cockpit radar—fire-control radar—airport surveillance—transient studies—data transmission, including half-tones—visual communications via narrow-bandwidth transmission? If you are, then don't overlook the unique advantages of the RCA-6866.

For technical bulletin on the 6866, write RC. Commercial Engineering, Section E-19-Q Harrison, N. J. For sales information on th and on other RCA display storage tubes nc in development... contact the RCA Fie Office nearest you.

East: HUmboldt 5-3900
744 Broad Street
Newark 2, N. J.

Midwest: WHitehall 4-2900
Suite 1181
Merchandise Mart Plaza
Chicago 54, Illinois

West: RAymond 3-8361
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Los Angeles 22, Calif.

RADIO CORPORATION OF AMERICA
Tube Division Harrison, N. J.